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THE IMPROVEMENT OF INDIAN CATTLE

THERE is probably no aspect of Indian agriculture which strikes even the casual observer more prominently and at the same time more painfully than the miserable condition of the cattle of the country, unless it be the thin emaciated form of the cultivator himself toiling patiently behind his equally patient team of oxen. And yet in no country is it more necessary that its cattle should be looked after better than in India, for as H.E. the Viceroy of India has observed in words that can never be forgotten "the cow and the working bullock carry on their patient backs the whole structure of Indian agriculture". The bullock supplies all the power on the farm, the ploughing, the raising of the water for irrigation, the threshing of the corn, and all the transport whether on the farm or on the roads; notwithstanding the new methods of motor transport the bullock cart still holds the field as the most important form of locomotion in the country, and even the pack bullock has not become altogether obsolete. The cow and the buffalo between them meet the whole of the requirements of milk and milk products of this vast country, hopelessly inadequate though they are, and cattle manure still forms the most important and generally the only source of manure. The money value of the cattle power alone has been computed to be between Rs. 300 and Rs. 400 crores, the milk and milk products at about Rs. 300 crores and the manure at about Rs. 270 crores, while the total value of the livestock of India inclusive of all the uses to which they are put is said to be of the order of Rs. 1,300 crores. The cattle population itself is immense, numbering about 200,000,000 head and forming roughly about one-third of the whole world's cattle population. Despite this prodigious number and the huge money value, India's cattle

wealth is however a neglected and ill-developed asset. The bullock power, large as it is, is poor and inefficient, and is contributed by small underfed and nondescript types of animals which lack the strength and stamina necessary for working even the small indigenous ploughs and other implements, and are out of the question for the better class of implements that can otherwise be advantageously introduced. Even in the tracts where a better class of animals is seen to predominate, insufficient feed lowers their value and the vice of indiscriminate and uncontrolled breeding is bringing in progressive deterioration in the qualities associated with the respective breeds. As is the case with the bullocks so is it with the cows of the country. The milk and milk products produced, vast as they are in quantity, are supplied by an immense number of cows and buffaloes whose low record of performance is a byword in the country-side. Large as the quantity is, moreover, it is too insufficient for average needs, especially in a country like India, whose population is largely vegetarian and has a special need in respect of dairy products which supply the accessory food elements considered indispensable for normal health. This position has long been one of grave concern, and ameliorative measures have been, and are being, taken by the provinces and states both for arresting this process of deterioration and for bringing about positive improvements. To give an idea of what these measures are we may describe in rough outline what has been done in Mysore, as this will serve as a sample more or less of what has been attempted elsewhere also.

These measures have been along three main directions, *viz.*, (1) the supply of an adequate number of breeding bulls of approved type to all the villages and alongside of it the castration in good time of all scrub bulls in the villages, (2) increasing the fodder resources of the State, including the improvement of the village pastures, grazing facilities in the forests and the planting of trees and shrubs of fodder value, and (3) the combating of disease among cattle. In regard to the supply of breeding bulls many methods, each having its own good points are being tried. These comprise: the sale of bulls and bull calves to *bona fide* breeders at a fair upset price instead of selling them by auction; the grant of a yearly subvention to breeders keeping bulls of approved type for service; the meeting by local bodies of a moiety of the purchase price of the bulls in the case of approved breeders willing to abide by certain conditions regarding inspection, keeping of records, etc.; the sale to village panchayats of bulls and bull calves, the purchase price being generally met by the district boards and these bulls being made to roam among the village herds and not made to stand for service; these bulls are to be maintained at the cost of the village jointly and are to be changed once periodically for other bulls at Government cost, the object being to avoid inbreeding and probably lack of vigour; stationing breeding bulls in some of the veterinary hospitals and Government farms for service in the neighbourhood; the institution of itinerant bulls in which bulls are taken out on circuit to a fixed number of villages in accordance with a programme notified well ahead to the villages comprising the circuit. For ensuring an adequate supply of bulls, selected animals in the herds of Amritmahal cattle are reserved, these cattle are bred more or less under semi-wild conditions; secondly is the stock raised on the special

cattle breeding farm of the Government and thirdly are the bull calves which are reared on the ordinary farms of the department. Simultaneously with this programme the veterinary staff carries out an intensive campaign of castrating scrub bulls, which forms an important item in their work during tours. In addition to these measures of the Government are the vastly greater endeavours of the cultivators themselves in providing their villages with good bulls, naturally to be expected in a state, which has been for centuries the home of a famous and popular breed of cattle. Money prizes and medals at the numerous cattle fairs give some additional incentive in the same direction. As an all-India subject this matter of the supply of breeding bulls has gained great strength from the personal interest of H.E. the Viceroy Lord Linlithgow, who made it almost the first act of his Viceroyalty to issue an appeal to wealthy Indian gentlemen to donate breeding bulls or funds for purchasing them, to which the response was prompt and liberal. His Excellency's interest has further resulted in a series of comprehensive measures for the improvement of live-stock, organised on a permanent basis under the auspices of the Imperial Council of Agricultural Research. The outward and visible symbol of this new development is the all-India cattle show which is now being held in Delhi every year. In the years to come this show will serve both as a touchstone to the success of these measures and also as the most substantial impetus to cattle improvement. The wide advertisement given to the best Indian cattle and the consequent high prices which are bound to be obtained will certainly prove a more potent stimulus than any other specific factor. We may illustrate this by recalling that the palmiest days of the breeders in Mysore were the years when the large cattle fairs were being visited by the agents of the Dutch East Indies who regularly made large purchases of the best animals at very high prices. Though these remarks refer to draft cattle they apply equally well to the bull as a sire in the dairy herd. An instance in this connection of which we have a vivid recollection is the case of the small holders of the Island of Jersey to whom their pedigree bulls and cows form the greatest source of income. The prices which some of these fetch fairly take one's breath away and it is no wonder that though the holding consists only of some five or six acres it enables the farmer to live in a style which a similar small farmer in India cannot even dream of. The ordinary village cow in India even when she is in milk yields too little to merit attention while the dry cow is so neglected that nothing but the owner's religious scruples prevent her from going into the hands of the butcher. She is too often such a great liability that even these scruples cannot stand the strain of her upkeep or the temptation of the butcher's offer. There is nothing that can save the situation except making the milk producing business pay, and the greatest single factor in the problem is a better type of animal. No better proof can be quoted than the fact that in many cities the local breeds of cows have been all but displaced by cross-bred animals. The development of motor bus traffic on our roads has however given a chance to the local cow, which is also bound to improve as cow keeping within city limits will eventually be given up voluntarily or by municipal enactments. Every good male calf born to her makes her position stronger, for these calves are much prized animals, and as thus her paying capacity increases so does it earn

for her better feed and attention, to which she in turn responds with a better performance. All this forms a powerful argument for better bulls and better methods of breeding in the villages so that the economic value of the cow may be increased both as the mother of valuable progeny and as the producer of more milk. In respect of the choice of the sires ryots have little information to go by, except vague hearsay accounts of the performance of individual specimens. A desirable line of development will be the formation of cattle breeding societies, the maintenance of performance records and of a pedigree register, all matters which, unfortunately under present conditions are fraught with great difficulties.

In an equal, if not greater measure, does the improvement of live-stock rest upon an improvement of the fodder resources of the country. No matter how great the improvement by breeding may be, the lack of adequate feeding will neutralise its effect, for without such feeding the improved stock will come down gradually to the level of the original stock, and may even have the disadvantage of being less fitted to withstand the rough conditions. It may be said that Indian systems of agriculture do not comprise a definite share in the rotation of crops solely intended for cattle feed, as does the British system where, for instance, from one half to three-fourths is for animal feed. Such areas as may be put down for cattle feed are either in special cases as for bullocks working at *mhotes* or for providing some amount of concentrated feed like horse-gram, but even this is a kind of left-handed affair, the roughest land being put under it and the produce in any case totally insufficient even for the working bullocks. Money crops like cotton and groundnuts have greatly increased in area and have made further inroads into the fodder capacity of the older rotations. The steady extension of cultivation has meant a corresponding shrinkage of grazing areas. Forests are being conserved in the wider interests of the country, and forest grazing is strictly controlled. The straw, chaff, husks, pods and other by-products which the ryot has to husband carefully for the use of his working bullocks have to be drawn upon by his other animals also, insufficient as they are for the needs of the former. Barring therefore the bullocks that work at the *mhote* or at the plough or for the professional carter and the cows and buffaloes actually in milk all other cattle are left to shift for themselves and what this means on the open parched up countryside can easily be imagined. The taunt that the ryot makes *pooja* to the stone bull in the temple but neglects it in its living flesh and blood form or that he venerates his cow but does not hesitate to leave her starving may thus appear justified, superficially at least. For the six months of the year before the period of heavy rains village cattle lead a painful life of semi-starvation, and if the rains fail or come late they are unequal to a further strain and succumb in large numbers, if they do not meanwhile meet a speedier end at the hands of the butcher. In the cities milking animals are maintained on the minimum feed necessary, for the milkman himself is poor and has to keep both himself and his cow on the slender returns from the milk. The dry cows are indeed a problem. One shudders to think of the hundreds of these animals, which are said to be sent to the slaughter houses in Bombay after they cease to milk, however good they might have been as milkers. Apart from feelings of softness or mercy, the salvage of these animals is a matter of

economic importance in which missions of mercy and pinjrapoles of a modern type may well play an important role.

The question of providing adequate fodder resources is being studied in a comprehensive manner by the Imperial Council of Agricultural Research, thanks again to the initiative of H.E. the Viceroy. In addition, the various states and provinces have bestowed a great deal of attention on it and taken measures both of a permanent character and more especially of an emergency kind to cope with wide-spread fodder scarcity and distress which unfortunately are of too common occurrence. First among the fodder sources come the village grazing grounds and the improvement of these grounds has engaged a great deal of attention. It has been found next to impossible to devise a practical scheme for converting them into good grass areas as long as the common ownership continues. The land will have to be fenced, ploughed and put under grass and the grazing carried out under strict control in a proper rotation, all the labour being provided or paid for by the villagers. The difficulties are all but insuperable and though several schemes can be considered the joint ownership will always remain the chief, if not, the sole obstacle. If, however, village autonomy should become powerful enough to enforce co-operative action in this matter then there is considerable scope for this form of improvement; after all joint action of this kind is not new in our villages and the village topes or groves affording at once both restful shade and a moderate money return are even now a standing proof that effective joint action is possible; many other forms of co-operative effort can easily be cited. But under present conditions when individual freedom is put before the needs of the community these grounds can serve as nothing more than mere exercising space for the village cattle during the crop season; as a matter of fact they are being fast reduced to this rôle, because in response to clamour for arable land parcels of pasture lands are gradually being given over for cultivation, leaving only the minimum required by the rules. It should be possible however for Governments to take up and improve large stretches of waste land and develop them as pastures in the manner described. Unpromising as these waste lands may appear in their present state, what can be effected on them is demonstrated by the forest plantations called "maidan" plantations in Mysore. In addition to the tree growth in these plantations grass grows abundantly forming a good source of income. We have heard from a late head of the forest department that the income from grass has paid for the maintenance of these plantations. The very fencing and the protection thereby afforded have a striking effect on the grass growth. These areas form veritable oases in the midst of the parched up country-side and an increase in their number is a desirable step. Trees of fodder value can be substituted for the ordinary fuel trees and these should greatly add to their fodder value. In a cattle country of great importance it will be also well to set apart large areas of forest land in the moister sections of the country and develop them with an eye to their grazing and fodder value, so that during seasons of acute fodder distress, the best cattle—the foundation stock, as it were—of the country may be sent away to these havens and saved. The conservation of forest grass by annual cutting and storage as hay will also have to be undertaken. No doubt all this will cost money and not all of them may be

considered necessary in ordinary years, but they have to be looked upon as a measure of insurance, justified by the importance of the cattle industry and the magnitude of the loss which results when a serious fodder famine sets in. In the long run, however, the ryot will have to face the fact, that the only remedy lies in his growing crops solely intended for fodder as part of his ord.nary farming; suitable adjustments will have to be made, cattle may have to be reduced in number, and replaced by better ones, leguminous fodder will have to be grown, animals will have to be penned or tethered and grazed and farm wastes more carefully conserved. Much encouragement by Government will have to be given in the channel-fed areas for the raising of fodder crops. The subject of mixed farming will have to receive more attention and methods suited to different tracts worked out and popularised.

We now come to the third leg of this tripod on which the improvement of the live-stock industry rests, *viz.*, the prevention and cure of diseases, especially the great cattle epidemics. This is a matter which needs no emphasis, but we may point out that one at least of the reasons why too many cattle are kept is the ryot's anxiety to guard against the depletion by disease. Rinderpest, the most dreaded of the epidemics, is sometimes partial to the larger and better class of cattle and the death of such animals brings a legacy of debt which it takes years for the owner to work out. By the wiping out of the products of good breeding the work itself receives a serious set-back. Fortunately we have in the new methods of serum treatment an almost infallible method of preventing rinderpest and to a lesser degree, the other diseases also, and it is now only a question of extending the treatment over the whole country. Research in animal diseases is now receiving great attention and before long suitable remedies may be forthcoming for other diseases as well, so that we may consider that this great obstacle has been overcome.

There is one other method of cattle improvement usually considered in this connection, *viz.*, the subject of cross breeding with the humpless cattle of Europe. This has been undertaken in India and very striking increases in the milk yield have been obtained. Both in the military dairy farms and in the Palace dairy farm in Mysore remarkable results have been attained and among city dairymen the cross-breds are exceedingly popular. For quick results among dairy cattle the method has no equal and, with proper safeguards against disease, is full of promise. Its field of limited application and the need for great precaution and control to prevent indiscriminate breaking of the type of the local cattle and the fact that it is still of an experimental character have lessened its importance.

It cannot be too strongly emphasised in conclusion that the greatest impetus to cattle improvement can come only by making it remunerative. Make the industry pay and the rest will follow automatically. The larger the custom and the higher the prices for our cattle, the greater the stimulus and the better will they be looked after. Nor need we fear that any large sale of cattle to foreign markets would endanger the permanent interests of the industry and that ryots will in view of immediate profits deplete their stocks.

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A BIVARIATE EXTENSION OF FISHER'S Z TEST

BY

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A NORMAL distribution in k variates $x_1, x_2, \ldots x_k$, each with expectation (population mean) zero is defined by the probability density $c \exp - \phi/2$, where c is always to be understood as a constant so chosen as to make the total probability equal to unity, and ϕ is a positive definite homogeneous quadratic form in the variates, *i.e.*:

$$(1) \qquad p = \frac{1}{\sigma(2\pi)^{\frac{k}{2}}} \int_R \cdots \int e^{-\frac{\phi}{2}} dx_1 \cdots dx_k;$$

$$\phi = \sigma^{ij} x_i x_j.$$

$$\sigma^{ij} = \sigma^{ji}; \; \sigma^{ir} \sigma_{ij} = \delta^i_j; \; \sigma^2 = |\sigma_{ij}|.$$

Here, we use the tensor summation convention for repeated indices and the integral is to be taken as extended over that portion of the k-space in which the variates are to lie. The coefficients σ_{ij} are to be formed by taking the normalized co-factors of the corresponding element in $\| \sigma^{ij} \|$, as usual. Alternatively, we can write $\sigma^{ij} = \dfrac{\partial \log \sigma^2}{\partial \sigma_{ij}}$. The form ϕ being definite, the determinant σ^2 does not vanish, and there is no theoretical difficulty in finding either σ^{ij} or σ_{ij}, the matrix of the other coefficients being given.

Suppose now that a sample of n observations be taken from such a population, the jth sample value of the variate x_1 being x_{ij}. Then it is known that the best[1] estimates of σ_{ij} are given by

$$(2) \qquad s_{ij} = \frac{1}{n-1} \sum_{r=1}^{n} (x_{ir} - \bar{x}_i)(x_{jr} - \bar{x}_j),$$

$$\text{where} \quad \bar{x}_i = \frac{1}{n} \sum_{j=1}^{n} x_{ij}$$

The best[1] estimate σ^2 is $s^2 = |s_{ij}|$ and of σ^{ij}, the corresponding normalized co-factors, s^{ij}.

It is well known that the quantities s_{ij} are the sample variances when $i = j$, and the sample correlations multiplied by the corresponding standard deviations when $i \neq j$. Again, s^2, the determinant of the sampling coefficients, has a strong claim to be considered as the generalized variance of the multivariate sample. The ratio of two such variances chosen from the same populations would be independent of a linear homogeneous transformation of the co-ordinates, and also of the population parameters. It is natural to ask whether the distribution of this ratio, or rather of its logarithm, has anything in common with Fisher's z, so that the z tables could be used without further ado. The answer is negative in general, but it is the purpose of this note to point out the fact that for a bivariate population ($k = 2$), such an extension is valid.

2. Following the methods given by Uspensky,[2] it is a comparatively simple matter to find the distribution of S, where

$$(3) \qquad S^2 = \det \cdot \left\{ \sum_{r=1}^{n} (x_{ir} - \bar{x}_i)(x_{jr} - \bar{x}_j) \right\}; \quad i, j, = 1, 2.$$

It is to be noted that $s^2 = S^2/(n-1)^2$. By a distribution, we mean the probability that $S^2 < t^2$, the derivative of this with respect to t being then the probability density, which is sometimes called the "distribution" by statistical writers.

For convenience of notation, let the two variates be x and y. The $\phi = ax^2 + 2bxy + cy^2$. But as we mean ultimately to consider the *ratio* of two generalized variances, which is a function independent of linear homogeneous transformations, we might as well consider the transformation to have been performed in advance which brings ϕ to its canonical form: for a positive definite form, $\phi = x^2 + y^2$. The required distribution is then given by

$$(4) \qquad p(t) = \frac{1}{(2\pi)^n} \int_R \cdots \int e^{-\frac{1}{2}(x_1^2 + \cdots + x_n^2 + y_1^2 + \cdots + y_n^2)} dx_1 \cdots dx_n dy_1 \cdots dy_n.$$

where the region of integration R is defined by the inequality:

$$(5) \qquad S^2 = \Sigma(x_i - \bar{x}) \Sigma(y_i - \bar{y}) - \{\Sigma(x_i - \bar{x})(y_i - \bar{y})\}^2 < t^2;$$

$$\text{with} \quad \bar{x} = \frac{1}{n} \Sigma x_i, \qquad \bar{y} = \frac{1}{n} \Sigma y_i.$$

The variates x and y have the sampling values $x_1, \ldots x_n; y_1, \ldots y_n$, which are independent, being chosen at random by hypothesis, and the formulæ (4 – 5) are then self-evident.

For the reduction of the integral, the

treatment by Uspensky for the distribution of the correlation coefficient is rigorous and can be carried out step by step. Choosing the new variables of integration as the means $\bar{x}$, $\bar{y}$, and $n-1$ each of the differences $x_i - \bar{x}$ $y_i - \bar{y}$, and performing a suitable linear homogeneous transformation, the integral in (4) is reduced to a similar one with $n-1$ in place of n, the usual loss of a degree of freedom for measuring from the sample mean. A second transformation and one integration will reduce the integral further to

$$(6) \qquad p(t) = c \int_R \cdots$$

$$\int e^{-\frac{1}{2}(w_1^2 + \cdots w_{n-1}^2 + \xi_1^2 + \cdots + \xi_{n-2}^2)} dw_1 \cdots dw_{n-1}\, d\xi_1 \cdots d\xi_{n-2};$$

$$R: (w_1^2 + \cdots + w_{n-1}^2)(\xi_1^2 + \cdots + \xi_{n-2}^2) < t^2$$

But we have the two classical formulæ of integration:

$$(7) \quad (a): \int_0^\infty e^{-x^2 - \frac{a^2}{x^2}} dx = \frac{\sqrt{\pi}}{2} e^{-2a}$$

$$(b): \int\cdots\int_{x_1^2 + \cdots x_r^2 < a} e^{-\frac{1}{2}(x_1^2 + \cdots + x_r^2)} F(x_1^2 + \cdots + x_r^2)\, dx_1 \cdots dx_r = \frac{\pi^{\frac{r}{2}}}{\Gamma\left(\frac{r}{2}\right)} \int_0^a e^{-\frac{u}{2}} u^{\frac{r}{2}-1} F(u)\, du$$

These allow us at once to write down dp/dt in the form:

$$(8) \qquad \frac{dp}{dt} = c\, e^{-t}\, t^{n-3}: \text{ range } t = 0 - \infty.$$

This is, again, of the form of the integrand for the incomplete gamma function, and so, if we wish to find the distribution of the ratio of two independent sampling observations of S^2, we can proceed as usual. But it is clear that the exponent is not the usual number of degrees of freedom. In fact, the degrees of freedom, as is to be seen by comparing exponents with those in the usual formula, are now $2n-4$. Thus, we must use $(2n-4)^2$ as the divisor for S^2 in place of $(n-1)^2$. Finally, a last correction is necessary for the fact that we have used $S^2 < t^2$ in place of the usual distribution, which would be the probability $S^2 < t$. All of this, however, is now quite obvious, and the result can be summed up in a theorem:

If two independent samples of n, n' specimens are taken at random from a bivariate normal population, then the quantity

$$(9) \qquad z = \frac{1}{4}\log\frac{S^2}{S'^2} + \tfrac{1}{2}\log\frac{n'-2}{n-2} = \log\left\{\sqrt{\frac{S}{n-2}}\Big/\sqrt{\frac{S'}{n'-2}}\right\}.$$

has the same distribution as Fisher's z for a single variate, with the degrees of freedom $2n-4$, $2n'-4$.

The distribution was known (Wilks,[3] 478) but the adjustment for the proper number of degrees of freedom, and the possibility of using Fisher's tables, have apparently been overlooked. The rule is quite as simple as for a single variate. In the usual notation we calculate the quantity $s^2_x s^2_y (1-r^2)$, multiply by the correction factor

$$(n-1)^2/4(n-2)^2,$$

and take a *quarter* instead of a half of the natural logarithm of the ratio of two such sampling observations. Then, enter Fisher's tables of z as usual, but with the degrees of freedom $2n-4$ instead of $n-1$.

3. The results of the preceding section are not extensible to $k \geqslant 3$. The integrals do not reduce so easily, at least by any known formulæ. For example, the case $k=3$ can be solved completely if an explicit formula for the integral from zero to infinity of $\exp - (x + a^2/x^2)$ is found. But it does not seem possible that this would allow a rigorous use to be made of the z tables.

It would be interesting to see the extended z test for $k=2$ used for analysis of variance: say for plot experiments with two simultaneous crops sown on each plot. The test is open to the same criticisms levelled against the z test for one variate, in that it does not take the mean values into account, but tests directly on the basis of the observed variances, the hypothesis that both samples might have been drawn from the same normal population. For tests also taking the mean values into account, as in Student's t test, we have the T^2 of Hotelling and its generalizations. But for a bivariate population, the test suggested here is surely more complete than the usual method of testing the variances s^2_x, s^2_y individually, along with the correlation coefficient r.

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1 J. L. Coolidge, *Theory of Probability*, Oxford, **1924**, p. 82.

2 J. V. Uspensky, *Introduction to the Mathematical Theory of Probability*, **1937**, p. 332, *et. seq.*

3 S. S. Wilks, "Certain Generalizations in the Analysis of Variance," *Biometrika*, **1932**, **24**, 471–494.

MATHEMATICAL OBFUSCATIONS IN BIOLOGY*

BY

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MATHEMATICS AND MICROMATHEMATICS

THAT averages should be corrected for probability; that a rupee when tossed with the same balance and force will give as many heads as tails only when the number of tosses is large; that fluke chances turn up; and that the chances with a rupee are essentially different from those with a dice, we are pleased to know. We will even buy books and renew our acquaintance with algebra and differential calculus. This is mathematics. That figures must be plotted on complicated curves; that equations well stocked with ∫s, d's and √'s should be constructed; and that many letters of the alphabet should be distorted or dislocated to trap and hold some elusive quantities, before we record observations on events in the lives of plants and animals, we may not consider significant. This is micromathematics. Probably Providence ruled the early cosmos with rigid mathematics even of the micro variety. The rigidity has definitely been relaxed since the birth of protoplasm. So far as its application to the activities of the protoplasm is concerned the micromathematics is a figment of the mathematicians.

EXAMPLES OF FAILURE OF EVEN SIMPLE ARITHMETIC TO ACCOUNT FOR WELL-KNOWN BIOLOGICAL OCCURRENCES

Mendelism is too well known to be discussed in detail here. The nearest approach that Mendel made to his 3 : 1 ratio in a lifetime, was 2·81 : 1 (Holmyard)[1] or 2·84 : 1 (Ride).[2] The latter day knowledge of the behaviour of chromosomes in the formation and fertilisation of gametes, which is a histological fact, leaves no doubt whatsoever regarding the correctness of the ratio. So far as protoplasmic activities are concerned, however, 2·81 or 2·84 must be accepted as 3. A closer approximation is not possible.

Another, even more outstanding, example of the failure of simple arithmetic occurs in immunology, in the following relationship between the toxin of the diphtheria bacillus and the anti-toxin made to neutralize the toxin:—

1. A minimal lethal dose (M.L.D.) of diphtheria toxin is the smallest amount which kills a guinea-pig weighing 250 grammes in 4 days.
2. A completely neutralized dose (L_0) is the largest amount of toxin completely neutralized by 1 unit of diphtheria anti-toxin. It does not kill the guinea-pig.
3. A re-toxicated dose (L_+) is the smallest amount of toxin, which when mixed with 1 unit of diphtheria anti-toxin just kills the standard animal in the standard time. It acts like 1 M.L.D.

Dose 3 *minus* Dose 2 should be equal to Dose 1

or

L_+ *minus* L_0 should equal 1 M.L.D.

In actual practice $L_+ - L_0 = 8$ to 12 M.L.D. (Hewlett and McIntosh).[3]

One unit of the anti-toxin neutralizes 100 M.L.D.'s (Ehrlich's original standard). The excess, therefore, is 7 to 11 per cent.

Explanations of this anomaly, which are 'probably' correct, have been given. The fact, however, remains that the same looseness of relationship exists between all antigens and anti-bodies (including toxins and anti-toxins) regardless of the method used in testing.

THE FIGMENT OF THE MATHEMATICIANS IS NOT USED EVEN IN IMPORTANT HUMAN ACTIVITIES OF PEACE AND WAR

The producer of the raw material mostly works without machinery and has little scope for mathematical refinements. The manufacturer of goods works with machinery yet uses very little mathematics. The seller of goods prefers advertisement and *creation of demands* to the statistical analysis of the *existing demands*.

In sport, judging of form, handicapping or even forecasting of events by professional advisers is not based on a complicated system of calculation at all. If the existing system were faulty the micromathematicians would have at their disposal the wealth of all the totalisators in the world. Such is not the

* Abstracted and amended from an article by the author (Greval, 1940) in the *Indian Medical Gazette*, 1940, 75.

case. They have not fared any better than ordinary folks even at Monte Carlo where the protoplasmic interference with the turn of events is minimal.

When the leaders of nations choose between peace and war they do not do so in an atmosphere of higher and pure mathematics.

The High Threshold of Life Defies Micromathematics

The *threshold* is familiar to physiologists. Vital receptors take no cognizance of what comes to them unless it is worth considering. That is why micro-mathematical quantities are without effect. Even the non-living products of living organisms are imbued with the same peculiarity of reaction. The physical basis of the peculiarity in either case is the highly complicated structure of the protein molecule.

Thresholds are known in the behaviour of non-living matter. Flow of electric currents shows a hesitancy under certain conditions. Certain chemical reactions appear to sit on the fence for a while. The *quantum* is essentially a threshold effect. Biological thresholds are much higher.

When a case of pneumonia approaches the crisis the physician in attendance may visualize the psyche perched precariously on a very high threshold. It will either tumble back into the weary body or glide forth into the Great Beyond. Micromathematics does not reach the threshold and does not help in the treatment or prognosis.

[1] Holmyard, E. J., *Biology for Everyman* by the Late Sir J. Arthur Thomson (J. M. Dent & Sons, Ltd., London), 1934.

[2] Ride, L., *Genetics and the Clinician* (John Wright & Sons, Ltd., Bristol), 1938.

[3] Hewlett, R. T. and McIntosh, J., *A Manual of Bacteriology* (J. & A. Churchill, London), 1932.

A PRELIMINARY NOTE ON THE SEVERE MEXICAN EARTHQUAKE OF APRIL 15, 1941

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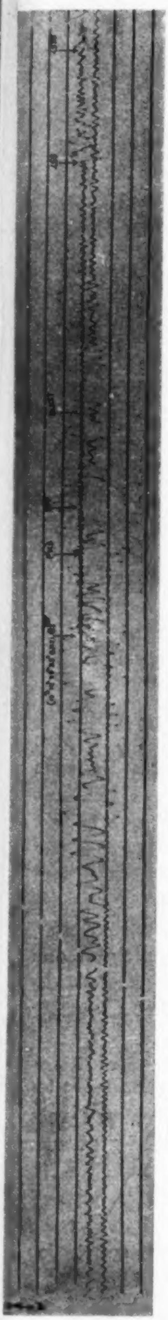
An earthquake shock of severe intensity rocked Mexico at 19^h 29^m Greenwich Mean Time (roughly about 13^h Mexican Standard Time) on Tuesday, the 15th April 1941. It is too early to get complete reports of the extent of area affected and the amount of damage caused; but the reports so far available from Mexico City state that the number of persons killed there exceeds 250 and that two towns, *viz.*, Tecatelan and Tuxpan in the State of Jabisco, have been wiped out. Many persons are reported to have been killed in the villages along the coast. Nearly three-fourths of the houses in Colima City have been either damaged or destroyed. A report from Vichy, supposed to be based on a message from Mexico City, states that most of the 15,000 inhabitants of the city of Colig are believed to have been either killed or injured. The volcanic group near Colima is reported to be in eruption and a tidal wave along the Jabisco coast has caused destruction to life and property in many villages. It would naturally take some days before the final casualty list will be available to us, but it is expected to be fairly heavy, judging from the nature of destruction.

Past history shows that the Mexican region is liable to experience severe earthquakes occasionally. During the last 13 years this region has felt as many as seven shocks of severe intensity including the present one. The extent of damage to life and property during these shocks varied to different degrees. The dates of occurrences of these shocks together with a brief description of the extent of damage done are given in Table I.

According to Milne's Catalogue[1] of Destructive Earthquakes, the total number of destructive earthquakes of intensity III (those that destroy towns and desolate districts) during the 17th, 18th and 19th centuries were 11, 8 and 16 respectively.

Epicentre of the Earthquake.—The seismographs at all the Seismic Stations of the India Meteorological Department, namely Bombay, Calcutta, Agra and Kodaikanal, as also those of the Nizamiah Observatory at Begumpet and the Haig Observatory at Dehra Dun have recorded this shock as one of great intensity. All the four departmental Seismic Centres have recorded P' as the first movement and that with an 'emersio'. SS is clearly recorded with an 'impetus' at all the four stations; the calculation of the



The Great Mexican Earthquake of April 15, 1941. Colaba Seismogram (Milne-Shaw Seismograph, E-W. Compt.).

TABLE I

Date of Earthquke	Intensity of shock as reported by the Press	Brief details of the extent of damage done	REMARKS
1931 Jan. 15	Violent (sharpest tremors ever experienced)	119 killed. Damage to buildings and property	
1932 June 3	Very severe	Widespread damage; more than 300 killed (reported to be the worst shock during the decade)	Shock of very great intensity by Bombay records
1934 Jan. 28	Severe	Many buildings damaged and several people injured	
1934 Sept. 19	Severe	9 killed and 200 injured	Phase movements in Bombay. Seismographs too feeble to be identified
1937 Dec. 23	Severe	Several houses severely shaken	
1940 May 19 or 20	Severe	9 dead and several injured	Movements too feeble in Bombay, records to be identified
1941 April 15	Severe	More than 250 killed and several towns demolished	Further details lacking at the time of going to Press

epicentral distances has been based on the SS–P' difference. The times of P' and SS as reported by these centres together with the calculated Δ (SS–P') are given in Table II.

TABLE II

Station	P' time (G.M.T.)			SS time (G.M.T.)			Δ
	H	M	S	H	M	S	°
Agra	19	29	14	19	49	29	134·1
Bombay	19	29	23	19	51	05	142·6
Calcutta	19	29	09	19	51	06	144·1
Kodaikanal	19	29	44	19	52	27	148·9

The tentative epicentre based on the above data with slight adjustments came to Lat. 15° N. and Long. 92° W., to the south-eastern border of Mexico.

Depth of Focus.—Without the seismograms from other centres no precise determination of the depth of focus of the earthquake is possible. The nature of the Colaba records, however, suggests a depth of focus in the neighbourhood of 120 Km.

During recent years (1932–39) this Mexican area has experienced Deep Focus Shocks[2] with epicentres varying between Lat. 12° N.; Long. 87·50° W.; and Lat. 18·75° N.; Long. 101·75° W. The depth in these cases varied from 70 Km. to 150 Km. Gutenberg and Richter have opined[3] that intermediate shocks (those with depths between 60 Km. and 250 Km.) occur in Mexico.

Magnitude and Energy.—Using the formulæ[4] $\log E_0 = \log E - 2M$ and $M = \log a - \log A_0 - 2{\cdot}5$, the magnitude and energy of the present Mexican 'Quake come to 7·7 and 10^{22} ergs respectively. The energy is equal to that of the Chilean shock of January 25, 1939, and ten times that of the Anatolian 'Quake of December 27, 1939.

As already stated, the telegraphic reports from the Departmental Seismic Centres point to a region near the south-east border of Mexico. In the absence of detailed reports regarding the extent of damage done, it is difficult to judge the preciseness of the tentative determination of the epicentre.

The Milne-Shaw Seismogram (E.–W. Compt.) of the Mexican Earthquake as recorded at the Bombay (Colaba) Observatory is reproduced in the figure.

1 *Br. Adm. Rept.*, 1911, p. 679.
2 Gutenberg and Richter, *Bull. of Geol. Soc. of America*, **50**, p. 1514.
3 *Internal Constitution of the Earth*, p. 293.
4 Gutenberg and Richter, *Gerlands B. Z. Geophysik*, **47**, p. 122.

OBITUARY

PROF. E. W. MACBRIDE

THE death of Prof. E. W. MacBride, F.R.S., Emeritus Professor of Zoology in the University of London on November 17, 1940, at the age of 73, has removed an outstanding personality from the zoological world.

Born in Belfast, Ireland, on 12th December 1866, he had his early education at Queen's College, Belfast, and in 1889 he graduated from London obtaining the University Scholarship in Zoology. He went to Cambridge where he distinguished himself and won the Exhibition and the Foundation Scholarship of his College, St. John's. His debating powers secured him the Presidentship of the Cambridge Union in 1891. He worked at the Zoological Station at Naples under Anton Dohrn, the founder and director of the Station during 1891–92. In 1892, he was appointed University Demonstrator in Animal Morphology at Cambridge and became Fellow of St. John's College next year. By this time, his researches had won for him international recognition and reputation and he was the first recipient of the Washington Medal for Biological Research. He left for Montreal in Canada in 1897, having been selected as the first Strathcova Professor of Zoology in the McGill University. In 1901, his first book written jointly with his Cambridge colleague Shepley appeared. This text-book of zoology was a success and had run through several editions since. In 1905, he was elected a Fellow of the Royal Society and next year (1906), the *Cambridge Natural History*, Vol. I, appeared, with the section on Echinodermata written by Prof. MacBride. Though he married in Canada a daughter of late Francis Henry Chrysler, K.C., of Ottawa, his zeal for science frequently took him to England, to renew his investigation and researches, until in 1909 he finally resigned his post and returned to England. He is next seen engaged in the heavy task of writing a comprehensive text-book of Invertebrate Embryology which, published in 1914, is still the standard text-book in the English language. This biggest achievement of his, he generously dedicated to his teacher Adam Sedgwick, whom he succeeded, on his pre-mature death, in the Imperial College of Science in 1913. It was a matter of great satisfaction and pride to him that he should have succeeded Adam Sedgwick in a place which was held, prior to Sedgwick by Sedgwick's teacher, the famous Thomas Huxley. Prof. MacBride used to delight on this genealogy. For over 21 years, till his retirement in 1934, he held the post in the Imperial College and turned out from his Huxley Laboratory a stream of research which honours the pages of scientific journals in England. Even after his retirement, we find him attending the Imperial College as Emeritus Professor of the University and guiding research at his old laboratory.

We in India, have reason particularly to mourn the death of Prof. MacBride. Apart from books which are in daily use in Colleges he has been the *guru* of several brilliant students who now occupy important zoological positions in India. Almost every province in India which has zoological activities can claim a pupil of Prof. MacBride in its service. Bombay, Madras, Calcutta, Aligarh, Travancore, Hyderabad can each claim one or more zoologists who had been Prof. MacBride's pupils. There is no other professor in England who can claim to have turned out as many Indian zoologists as Prof. MacBride has. It may well be claimed for him therefore that the recent zoological progress in this country owes a deep debt of gratitude to him.

Prof. MacBride was a most charming and inspiring personality that infused the young minds with a real thirst and spirit for research.

S. G. M. R.

LETTERS TO THE EDITOR

ULTRA-VIOLET BAND SPECTRUM OF HgBr

In continuation of the work on HgCl bands,[1] the ultra-violet band systems of the homologous molecules, HgBr and HgI have been investigated under similar experimental conditions. The characteristic bands between $\lambda 2900$ and $\lambda 2650$, designated as the Class II system and suggested by Wieland[2] as belonging to the triatomic molecule $HgBr_2$, have been ascribed by the author to the diatomic molecule HgBr and a vibrational analysis has been obtained. The constants determined for the band heads of $Hg^{202}Br^{81}$ are

$$
\begin{array}{llll}
\omega_e' = 459\cdot 0 \text{ cm.}^{-1} & & \nu_e(\text{mol}) = 34537\cdot 8 & \text{cm.}^{-1} \\
\omega_e'' = 372\cdot 3 & ,, & \nu(\text{atom}) = 4\cdot 92 & \text{volts} \\
x_e' \omega_e' = 3\cdot 6 & ,, & D' = 1\cdot 81 & ,, \\
x_e'' \omega_e'' = 3\cdot 8 & ,, & D'' = 1\cdot 15 & ,,
\end{array}
$$

The assignment of the quantum numbers is confirmed by observations of the isotopic heads due to $Hg^{202}Br^{79}$, for which the agreement between the observed and calculated positions is very close. The electronic transition giving rise to the band system is probably ${}^2\Sigma - {}^2\Sigma$ with negligible spin doubling, the dissociation products being $Hg(^1S) + Br(^2P)$ and $Hg(^3P) + Br(^2P)$ for the two electronic states. A full account of the work will be published shortly.

M. G. Sastry.

Andhra University,
Waltair,
March 22, 1941.

[1] *Curr. Sci.*, 1941, **10**, 669.
[2] *Helv. Acta Phy.*, 1929, **2**, 46, 77.

CRYSTAL STRUCTURE OF COUMARIN

Coumarin crystallises in the orthorhombic system with the axial ratio 0·9833 : 1 : 0·3696.[1] The dimensions of the unit cell obtained from measurements of a number of rotation photographs about the three crystallographic axes, using Cu K_α radiation, are 15·44, 7·92 and 5·66 A. $a : 2b : c$ is in agreement with the axial ratio quoted above. In the rotation photographs, spots of the type *hkl* are present in all orders while *okl* is halved if *k* is odd and *hko* is halved if *h* is odd. The possible space-groups are therefore V_h'' and C_{2v}^5 the former being a holohedral group and the latter a hemimorphic hemihedral one. Since coumarin exhibits hemimorphism about the *b* axis[1] it is to be concluded that C_{2v}^5 is the correct space-group.

Examination under a polarising microscope with convergent light reveals that the *c* axis is normal to the optic axial plane. The crystal is positive and the acute bisectrix is parallel to the *b* axis. This would mean that the vibration directions for the largest, mean and smallest refractive indices correspond to the *a*, *c* and *b* axes respectively.

The diamagnetic anisotropy of the crystal, determined for me by Dr. P. Nilakantan, is as follows:

$$(\chi_a - \chi_c)_M = 31\cdot 8 \times 10^{-6},\ (\chi_a - \chi_b)_M = 109 \times 10^{-6}$$
$$\text{and } (\chi_c - \chi_b)_M = 79\cdot 0 \times 10^{-6}.$$

Hence the anisotropy in the *ac* plane is comparatively small and $\chi_b > \chi_c > \chi_a$.

From the optical and magnetic data it is to be concluded that the molecule is orientated in the unit cell with its plane parallel or nearly so to the *ac* plane. Also the long axis of the molecule is parallel or nearly so to the *a* axis. A complete analysis of the crystal structure is in progress.

S. RAMA SWAMY.

Department of Physics,
Central College, Bangalore,
April 7, 1941.

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1 A. Cathrein, *Zs. Krist.*, **11**, p. 402.

OPTICAL SENSITISATION AND PHOTOVOLTAIC EFFECT OF DYES

VARIOUS attempts have been made from time to time to connect optical sensitisation with other physico-chemical properties. Zchodro[1] found complete correlation between light absorption and photo-conductance of three sensitising dyes, cyanine, pinaverdol and pinachrome. Bancroft, Ackerman and Gallagher[2] have connected the sensitising power of a dye with its capacity as a halogen acceptor. Kornfeld[3] thinks there may be some correlation between fluorescence and optical sensitisation and suggests an investigation of this property in sensitised emulsions. Leermakers, Carroll and Staud[4] have shown that absorption and optical sensitisation run parallel. A close comparison of the absorption and sensitisation of a photographic plate by the two dyes, Eosin and Erythrosin, reveals the fact that the maximum of sensitisation does not coincide with the region of maximum absorption of the dye, but is displaced a few wave-lengths to the red. It has however been stated, on the basis of the generally known fact that the absorption of a dye is appreciably altered by the properties of the solvent, what is of account in determining its sensitising action is not its individual absorption, but of the complex it may form with the sensitive emulsion. (This complex is in the nature of an adsorption complex and in some instances a peculiar edge-on adsorption or a nematic state has been assumed with entirely different properties of absorption.)[5]

I have shown elsewhere with reference to Erythrosin[6] that the maximum of photo-voltaic effect in aqueous solutions of the dye (where obviously no complicated adsorption phenomena may come into play) occurs in a region shifted a few wave-lengths to the red from the absorption head and does coincide with the region of maximum sensitisation of the photographic plate. At the same time I ventured the suggestion that the same factors probably come into play in giving rise to the two effects. I have since been able to extend these observations on three more dyes[7]—Methylene blue, Methyl green and Malachite green—all of which possess a second band of absorption in the less refrangible part of the visible spectrum. In every case may be seen two maxima of photo-potential corresponding to the two absorption bands and the wave-length displacement or shift is also unmistakably present. The sensitising action of these dyes on the light sensitive compound, HS.Hg.CNS., has already been noted[8] and a comparison of the photo-potential with the amount of optical sensitisation along the spectrum shows a definite parallelism, which is indeed more than a mere coincidence and suggests identity of origin for the two effects. The accompanying table illustrates this point.

TABLE I

	Absorption	Sensitisation	Region of maximum photo-potential
	$\mu\mu$	$\mu\mu$	$\mu\mu$
Erythrosin ..	455—560	560—600	580
Chrysoidin ..	360—540	..	546
Methyl green ..	550—6[illegible]0	580—690	580—690
Malachite green	from 550	530—620	615
Methylene blue	540—615 & 665—695	530—600	580

N.B.—In the case of the last three dyes the absorption in the blue-violet has not been given. Against sensitisation is noted only the region where it is very appreciable and amounts to a second maximum. In a general sort of way all the three dyes sensitise upto 700$\mu\mu$.

One may then draw the very reasonable conclusion that the mechanism by which optical sensitisation is produced is not very different from that by which photo-voltaic effects are produced. On the latter question fairly decisive evidence is available. Russell[9] and Ghosh,[10] more particularly the latter, pictured a primary or initial photo-chemical activation of the dye molecules, the photo-E.M.F. resulting from an impact of such activated molecules on the electrode surface. This picture coupled with that of deactivation by collision before impact enabled Ghosh to predict a number of characteristics of this photo-potential, *e.g.*, time lag, variation with intensity, etc., all of which are borne out by the data of Rule[11] on fluorescein and my own on no less than five dyes of widely differing character. In short, evidence has accumulated to point to a preliminary activation of the dye molecule by absorption of light. Photo E.M.F. or sensitisation is a secondary phenomenon arising from an impact of this activated dye molecule with the electrode or the sensitive emulsion (or other light sensitive body). Why in both cases the maximum activity is slightly shifted from that of maximum absorption, is a question which cannot be answered at the moment.

The phenomenon of desensitisation has similarly been much discussed. It has early been recognised that desensitisation is a property common to all sensitisers at higher concentrations. Desensitisation in all such cases refers only to the property by which the substance is rendered insensitive to the rays which are ordinarily active. The question has been probed if desensitisation does not mean sensitisation to the simple Herschel effect.[3] Weber[12] noticed that in a sensitised plate desensitising showed more strongly in the sensitised spectral region than in the absorption region of silver bromide. During experiments on sensitisation of phototropic changes[8] evidence has been recorded of the same dye and in the same concentration, sensitising the forward darkening process as well as the reverse bleaching process in a particular spectral region, although with much different efficiencies. The bleaching is a much slower process. On a close examination it shows that these dyes possess strong absorption in the region of normal reversal of the sensitised compound. Of significance in this connection is also the fact that such of the dyes which do not absorb the normal bleaching rays, *e.g.*, eosin and erythrosin, sensitise only the darkening process.

There is therefore strong reason for concluding that sensitisation and desensitisation are not two different phenomena, but constitute essentially a single phenomenon in which sensitisation may occur of one of two opposed processes or of both depending on the nature of the sensitiser. In the latter case, an apparent equilibrium between the two processes is established and the rôle of such dyes may be compared to that of catalysts in ordinary chemical reactions, provided however the comparison is pressed no further. Experiments are in progress on the behaviour of sensitised phototropic compounds (conductivity and voltaic activity) as well as silver halides which are calculated to throw further light on this complicated mechanism of optical sensitisation.

BH. S. V. RAGHAVA RAO.

Andhra University,
Waltair,
March 14, 1941.

1 *J. Chim. Phys.*, 1929, **26**, 59.
2 *Proc. Nat. Acad. Sci., U. S.*, 1931, **17**, 407.
3 *J. Phys. Chem.*, 1938, **42**, t07.
4 *J. Chem. Phy.*, 1937, **5**, 893.
5 Kornfeld, *loc cit.*
6 *J. Phys. Chem.*, 1934, **38**, €93.
7 Under publication.
8 *J. Phys. Chem.*, 1928, **32**, 1354.
9 *Phys. Rev.*, 1928, **32**, 667.
10 *Z. Physikal Chem.*, 1929, **3**, 419.
11 *Proc. Nat. Acad. Sci., U S.*, 1928, **14**, 272.
12 *Z. Wiss. Photo*, 1936, **35**, 124; 1937, **36**, 1.

PHOTOVOLTAIC EFFECTS IN DYE SOLUTIONS

CONTINUING former work[1] on aqueous solutions of Erythrosin and Chrysoidine, three new dyes, whose absorption extends well into the red have been investigated—Methylene blue, Methyl green and Malachite green. These dye solutions give rise to two absorption maxima and it should be interesting to note if the photo-potential also exhibits similar maxima. With reference to their photo-sensitising action it may be mentioned that when dyed on the phototropic substance, HS.Hg.CNS, a second maximum of darkening is noticed in the orange-red, the first in all cases practically coinciding with, or extending on either side by a short region of that due to the substance itself. These investigations yielded results similar in every way to those recorded before and confirmed the conclusions then arrived at, as will be shown presently. Further a far-reaching parallelism between the development of photo-potential and optical sensitisation may be traced which forms the subject of another communication.

A description of the apparatus will appear elsewhere in a fuller account of the work. It is however necessary to add that a vacuum type of mercury arc served as the source of illumination and potentials were measured with a vacuum tube volt-meter, in which the lighted electrode was connected directly to the grid and the dark electrode was biassed from the negative end of the filament to the potential of the free (floating) grid. Under these conditions the grid current being actually zero at the start and negligibly small at the end of a run, polarisation of the cell does not occur and the zero of the instrument does not drift.

The rise and fall of potential on insolation and cutting off the light, its variation with the concentration of the dye and intensity of illumination, do exhibit complete similarity to the dyes already examined. In the composite light of the mercury arc, Methylene blue develops a potential of 12 m.v. at a concentration of 0·0009 mg. per ml., Methyl green 10 m.v. at 0·0024 mg., and Malachite green 11 m.v. at 0·0015 mg. per ml. Of interest however is the variation of the photo-potential with the wave-length of the exciting radiation. The accompanying table gives these values corrected for the transmission factors of the spectral filters employed and the energy distribution of the mercury arc. It is particularly noteworthy that all the dyes develop maxima of photo-potential corresponding to their absorption maxima in the different regions of the spectrum and shifted therefrom by a few wave-lengths to the red.

Calculated photo-potential and wave-length

	Methyl green	Malachite green	Methylene blue
	m.v.	m.v.	m.v.
Composite light ..	10,0	11,0	12,0
436 $\mu\mu$ ..	7,0	4,0	7,5
546 ..	2,0	6,0	6,0
577–9 ..	8,0	7,0	14,0
615 ..	11,0	12,5	10,0
690 ..	9,0	7,0	8,0
700 ..	3,5	4,0	5,0

BH. S. V. RAGHAVA RAO.

Andhra University,
Waltair,
March 14, 1941.

[1] *J. Phys. Chem.*, 1934, **38**, 693.

VERIFICATION OF KAUFMANN CONDITION, FOR ARC DISCHARGE IN MERCURY

KAUFMANN[1] derived the condition for the stability in glow discharge. He showed that the *limiting point* on the falling characteristic of voltage against current in a glow discharge which will give the *smallest current* under which the glow could be maintained depends on the external resistance W in the circuit. His condition can be expressed as $W = -\tan\ \beta$

where β is the angle which the tangent to the characteristic at the point makes with the current axis.

In this note we wish to show that this condition holds and can be verified in the case of *arc* discharge in mercury.

The mercury arc characteristic as obtained with a mercury lamp of the high vacuum type is a straight one, in which the voltage across the arc rises with increase of current flowing through, *i.e.*, it is a rising characteristic as shown by Henri[2] as well as Daniels and Heidt.[3] Therefore there is no question of the Kaufmann condition being fulfilled here, at all, as tan β is positive and no falling part in the characteristic of mercury was known.

All efforts by us to get a falling part in the characteristic proved futile in highly evacuated arc lamps of mercury. If however a small amount of air is introduced, so that the air pressure in the arc space is about 0·5 mm. or more, then it is possible to get the falling part. It becomes more and more prominent as the pressure is increased.[4] The development of the negative characteristic can be brought about also by cooling the arc for example by blowing currents of air from different distances, with an electric table fan, provided the pressure

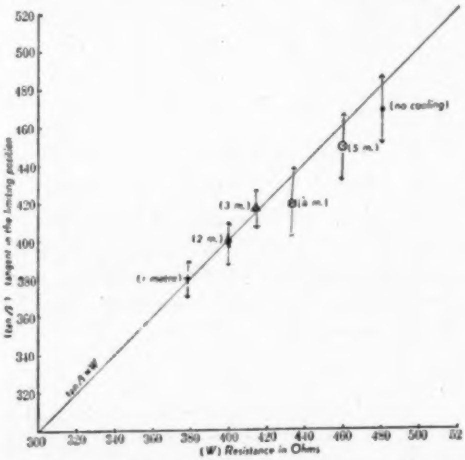

Fig. 1

Verification of Kaufmann condition

(inside air pressure) is not lower than about 0·5 mm. of mercury. From such curves we can obtain the tangents at different points.

The figure above shows the values of the tangents as ordinates obtained for the limiting points when an arc is maintained in a mercury arc lamp made out of soft glass, and cooled by the fan to different amounts. The abscissae show the actual values of the resistance in the external circuit. The tangents obtained with coolings at distances of fan of 1, 2, 3, 4 and 5 metres, and also without any cooling by fan are shown in the figure. The deviations in the values of the tangents under a particular condition are indicated by arrows. The points fall on a straight line inclined at 45° to the axes, showing that the tangent condition is strictly fulfilled. These points show that their value increases with decrease of cooling, *i.e.*, by removing the fan farther and farther away. We also verified this condition with two different mercury lamps.

B. Dasannacharya.
C. Dakshinamurti.

Department of Physics,
Benares Hindu University,
March 26, 1941.

[1] W. Kaufmann, *Ann. d Phys.*, 1900, **2**, 158.

[2] Henri, *Comptes Rendus*, 1911, **153**, 426, quoted in the paper by Lewis Reeve; *J. Phys. Chem.*, 1925, **29**, 39.

[3] F. Daniels and L. G. Heidt., *J. Am. Chem. Soc.*, 1932, **54**, 2381.

[4] See B. Dasannacharya and C. Dakshinamurti, *Curr. Sci.*, 1941, **10**, 166.

MODIFIED EQUATIONS FOR ADSORPTION AND BASE-EXCHANGE IN SOILS*

When a calcium soil is treated with a solution of Na_2CO_3 the following base-exchange reaction takes place:

$$CaZ + Na_2CO_3 \rightleftharpoons Na_2Z + CaCO_3$$

This equation however does not express all the significant factors connected with the reaction.

*[This work is being done under the auspices of the Irrigation Department (Research Section) of the U P. Government.]

Firstly there is adsorption of sodium carbonate by the soil, and secondly there is the base exchange; the two are related but not necessarily equivalent. For example the sodium carbonate adsorbed is not equivalent to but is generally greater than the calcium exchanged. Hence the two aspects may be treated separately; the first may be spoken of as general adsorption, and the second leading to the base exchange as "exchange adsorption".

In a number of experiments it was found that the adsorption of sodium carbonate by Ca-soils was governed by the well-known Freundlich equation:

$$y = aC^{\frac{1}{n}}$$

where y is the quantity of sodium carbonate adsorbed, C the equilibrium concentration, and 'a' and 'n' constants.

In nine soils examined (Table I) it was found that 'n' varied within narrow limits (0·8 to 1·1) while 'a' varied within wide limits. The latter is presumably a characteristic of the particular soil.

When the constant 'a' is plotted against the base-exchange capacity 'B' we obtain a parabolic curve, and that it is a parabola is further confirmed by the fact that when 'a' is plotted against 'B^2' we get a straight line (Fig. 1). Thus it is seen that the constant 'a' in Freundlich's equation seems to be a function of the base-exchange capacity of the soil. The modified equation therefore is:

$$y = kB^2C^{\frac{1}{n}}$$

The average value of n comes to 0·903, and that of k to 31×10^{-5} for nine soils examined (base-exchange capacity of these soils varied from 7·9 to 20·52 m.e.). Hence the adsorption formula may finally be stated as:

$$y = 31 \times 10^{-5}B^2C^{\frac{1}{n}}$$

[A similar attempt to connect base-exchange capacity with adsorption of K^+ and NH_4^+ ions by soils was made by Fudge[1] where he has given the values of $\frac{a}{B}$ which however is not a constant but is of the same order of magnitude, while $\frac{a}{B^2}$ gives still more varying results.]

The exchange adsorption does not follow Freundlich's rule. A number of equations have been proposed by various workers.[2] Two of these equations, *viz.*:

TABLE I

Soil No.	Mechanical Clay %	Composition Silt %	Base exchange capacity m.e. (B)	a	n	$a/B^2 \times 10^{-5}$
3	52·43	39·20	13·40	·0497	1·110	28·0
12	27·44	50·25	14·80	·0721	·912	32·6
9	16·53	23·08	10·00	·0352	·816	35·2
4	6·00	18·50	7·90	·0186	·816	29·0
5	27·60	58·90	20·52	·1350	·924	32·0
6	26·60	58·90	11·60	·0404	·823	30·0
10	24·53	44·24	16·60	·0854	·924	31·0
13	21·85	17·36	9·88	·0303	·812	31·0
16	26·32	21·24	7·11	·0160	·824	31·7

(1) $x = \frac{hC}{1+bC}$ (Langmuir's)

(2) $x = \frac{SI}{I+K}$ (Vageler's)

x = base exchanged
C = equilibrium concentration
I = initial concn.
h, b, K, S, constants.

TABLE II

(*Soil 12; Clay 27·44%; Silt 50·25%;* B 14·80)

1 Exchangeable Ca exchanged (observed)	Calculated by the formulæ			
	2 $x=\frac{bC}{1+bC}$	3 $x=\frac{SI}{I+K}$	4 $x=\frac{BU}{I+C'}$	5 $x=\frac{\mu+IB}{\lambda+I}$
·80	(·80)	(·80)	(·80)	(·80)
·88	·867	·908	·949	·883
·96	·953	1·050	1·091	·965
1·05	·992	1·092	1·239	1·053
1·12	1·000	1·172	1·379	1·125
1·21	1·158	1·240	1·506	1·123
1·40	(1·40)	(1·40)	(1·75)	(1·40)

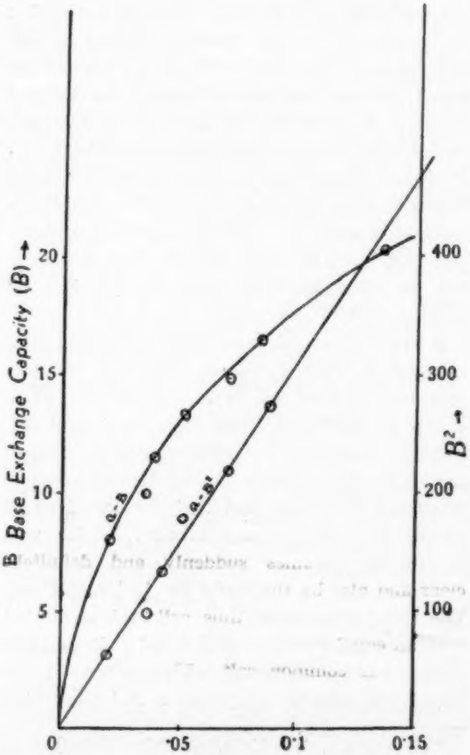

FIG. 1

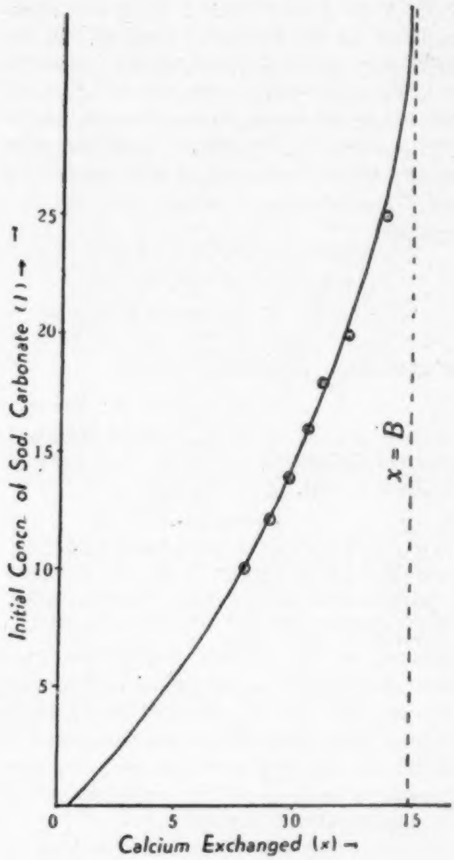

FIG. 2

have been examined here. One typical result is given in the following table:

Column No. 4 gives values for an equation similar to that of Vageler but the constant S has been replaced by B the base-exchange capacity. The values suggest that another constant is required and hence the equation in the last column.

In six soils examined so far the new equation has been found to be in better agreement with observations, while Vageler's equation is the next best. The merit of the new equation is that it takes account of B, the base-exchange capacity, an important characteristic of the soil.

When I (initial concentration of absorbent

Na_2CO_3) is plotted against x (the Ca exchanged) we get the curve (Fig. 2). In the graph the line $x = B$ (base-exchange capacity) is an asymptote of the curve (I, x) which has been confirmed by experimental results also.

Langmuir's and Vageler's equations were found to be not applicable at very low or very high concentrations, while the modified equation:

$$x = \frac{\mu + IB}{\lambda + I} \left\{ \begin{array}{l} x = \text{Ca exchanged} \\ I = \text{initial concn. of } Na_2CO_3 \\ B = \text{base-exchange capacity of the soil.} \\ \lambda, \mu \text{ constants.} \end{array} \right.$$

is applicable within wide limits.

K. P. Shukla.
M. R. Nayar.

Lucknow University,
April 2, 1941.

THE EFFICIENCY OF SOME SPECIAL PETROLEUM FRACTIONS AS WATER "ENTRAINERS" IN THE INDUSTRIAL DEHYDRATION OF ETHYL ALCOHOL

Benzene is the common liquid used as a water entrainer in the manufacture of absolute alcohol. The use of some petroleum hydrocarbons along with benzene was first suggested by Guinot[1] and since used frequently as a complement of benzene in the azeotropic process of absolute alcohol manufacture.

A very cheap source of water entrainers for the dehydration of 96 per cent. ethyl alcohol which can displace benzene, a relatively costly material, is the petroleum hydrocarbons. For example, n-hexane, *cyclo*-hexane, n-heptane and *cyclo*-hexadiene and many other homologues form ternary azeotropic mixtures with alcohol and water. N-hexane forms the ternary mixture at 56·6° C. and *cyclo*-hexane at 62·1° C. In fact, such low boiling points are really advantageous in the smooth working of the azeotropic process. But, the isolation of these individual hydrocarbons from the petroleum products is rather a costly and an arduous task. This was probably the reason why the use of such petroleum fractions which contain as much as possible of the useful hydrocarbon constituents, was suggested to be used along with benzene in large-scale operations.

This investigation was taken up with a view to find out the efficiency of two such special fractions of petrol, one of continental source and the other of indigenous origin, used in the Mandya Distillery.

By efficiency of an entrainer is meant chiefly, pounds of water withdrawn per pound of the entrainer used. Besides this, factors like the relative volumes of top and bottom layers of the ternary mixture distillate, the distribution of water in the two layers and the formation of binary mixtures interfering with the formation of the ternary mixture are also important.

The amount of water entrained is evaluated by determining the composition of the ternary azeotropic mixture. The middle point method[2] of determining the composition of the azeotropic mixture of petrol, alcohol and water, is not practicable on account of the very complex nature of petrol. The method adopted in this investigation was this:—When a mixture of petrol, alcohol and water forming the ternary mixture of minimum boiling point is distilled, the separation may take place, theoretically in 13 ways.[3] Commonly, 5 cases are met with and they are the following: (i) P.A.W. (first fraction); A.W. (second fraction); and W. (residue). (ii) P.A.W.; P.W.; W. (iii) P.A.W.; A.P.; and A. (iv) P.A.W.; P.W.; and P. (v) P.A.W.; A.P.; and P.*

About 200 c.c. of the mixture in each case, as given in Table I, are distilled at a uniform rate of about 40–45 drops per minute, with a 7-pear still head. The first fraction of the distillate is the ternary mixture and the transition from the ternary to the binary mixture is evidenced by the fact that the last drop of distillate of the ternary mixture, which will be turbid, becomes suddenly and definitely clear and also by the rapid rise in temperature. The ternary distillate thus collected is diluted with an equal quantity of distilled water, a little quantity of common salt added, when all the petrol separates as a top layer. After repeated

* (P = Petrol, A = Alcohol and W = Water.)

washing of the layer its weight is determined. The lower layer of alcoholic solution is then distilled and the alcohol determined by a hydrometer. Water is obtained by difference.

Table I shows the composition of the azeotropic mixtures of two special fractions of petrol (denoted by P_1 and P_2).

water, and from Table II it is apparent that one lb. of benzene should withdraw 0·098 lb. of water. The ternary azeotropic mixture of P.A.W. when condensed separates into two layers. The percentage by volume of the two layers at 30° C. is given in Table III. The upper layer which forms about 43 to 44 per

TABLE I

Sample P_1: Sp. gr. 0·732 at 15° C. Ref. Index N_D^{27} 1·403. Boiling range = 95%/100° C.

Weights taken (Grms.)	Case 1	2	3	4	5	
Petrol	64·38	93·99	79·52	108·02	95·57	
Alcohol	54·41	31·11	65·96	31·71	50·67	
Water	39·84	29·87	5·48	9·97	5·48	
Total ..	158·63	154·97	150·96	149·70	151·72	
Wt. of ternary mixture ..	100·31	93·71	100·4	98·77	101·91	
Composition per cent. by weight (Atm. pressure = 700 mm.)						Average
Petrol	61·79	62·76	62·82	62·37	63·02	62·55
Alcohol	31·86	31·41	31·58	32·10	31·66	31·73
Water	6·35	5·83	5·60	5·53	5·32	5·72

Sample P_2: Sp. gr. 0·760 at 15° C. Ref. Index N_D^{27} 1·415. Boiling range = 90%/110° C.

Weights taken (Grms.)	Case 1	2	3	4	5	
Petrol	62·51	92·50	80·18	110·55	101·15	
Alcohol	50·80	31·23	65·44	29·93	42·73	
Water	49·77	34·82	6·22	10·00	6·22	
Total ..	163·08	158·55	151·84	150·48	150·10	
Wt. of ternary mixture ..	102·23	100·32	95·64	103·21	103·58	
Composition per cent. by weight (Atm. pressure = 700 mm.)						
Petrol	63·36	62·63	60·80	61·09	63·48	62·27
Alcohol	29·90	31·12	32·70	32·90	30·54	31·43
Water	6·74	6·25	6·50	6·01	5·98	6·30

The composition of ternary mixture of benzene, alcohol and water, determined similarly, is given in Table II.

Table III gives boiling range and other details of the binary and the ternary mixtures.

From Table I, it is seen that one pound of sample P_1 should withdraw 0·091 lb. of water, while sample P_2 should entrain 0·101 lb. of

cent. of the mixture contains on an average 89 per cent. petrol, 10·5 per cent. alcohol and 0·5 per cent. water (by volume). The top layer is returned to the still for forming fresh ternary mixture. Thus actually one pound of sample P_1 withdraws effectively 0·088 lb. of water and P_2, 0·096 lb. Similarly, one lb. of benzene effectively withdraws 0·091 lb. of water.

TABLE II

Benzene: Sp. gr. 0·883 at 15° C. Ref. Index N_D^{31} 1·497

	Case 1	2	3	4	5	
Benzene (grms.)	81·33	124·80	115·60	141·76	130·18	
Alcohol „	54·74	19·11	45·05	18·31	32·17	
Watar „	35·82	30·84	7·43	13·43	7·46	
Total ..	171·89	174·75	168·08	173·50	169·81	
Wt. of ternary mixture ..	112·30	106·70	105·60	106·20	107·79	
Composition per cent. by weight (Atm. pressure = 700 mm.)						Average
Benzene	75·2	74·73	75·23	74·20	75·24	74·92
Alcohol	17·1	17·91	17·21	18·90	17·84	17·77
Water	7·7	7·36	7·56	6·90	6·92	7·31

TABLE III

Sample	Binary Mixture	Boiling Range °C.	Ternary Mixture	Boiling Range °C.	Per cent. by Volume of top and bottom layers (Temp. 30° C.)
P_1	P_1. A.	68·5° to 70·5°	P_1. A. W.	66° to 68·5°	Top .. 56% Bot. .. 44%
P_1	P_1. W.	74° to 80°	..	..	..
P_2	P_2. A.	66·5° to 71°	P_2. A. W.	62·5° to 69·5°	Top .. 57% Bot. .. 43%
P_2	P_2. W.	72° to 85°	..	..	..
Benzene	B. A.	66·25°	B. A. W.	63·0°	Top .. 87% Bot. .. 13%
„	B. W.	67·5°	..	..	..

From Table III we notice that the binary mixture of P_2.A. is formed between 66·5° to 71°, whereas the ternary mixture of P_2.A.W. is formed between 62·5° to 69·5°. It will at once be apparent that the formation of binary mixture of P_2.A. in the range 66·5° to 69·5° will diminish the efficiency of petrol as an entrainer as some of the hydrocarbons of the petrol form binary mixture with alcohol and distil over along with the rest of the hydrocarbons forming the ternary mixture with alcohol and water. It is found from the refractive index values that about 18 per cent. of the petrol (P_2) has constituents which form the binary mixture in the range 66·5° to 69·5°. Thus, in the composition of ternary mixture this correction has to be allowed for, when, in fact, the efficiency of the sample would read much higher. In this particular instance, in spite of about 18 per cent. of the petrol (P_2) forming the binary mixture, the amount of water withdrawn is more than that of the sample P_1. But, in general, it may be mentioned that in the choice of entrainers, the formation of such binary mixtures interfering with the formation of ternary mixtures, is inadvisable,

because, besides being of no value in the dehydration of alcohol, they occupy unnecessary space in the still and they consume steam which is not profitably spent.

The lower layer of the ternary azeotropic distillate, which contains most of the entrained water, is treated in a separate still for the elimination of water and for the recovery of alcohol and benzene. With the petrol fractions, the lower layer forms about 43 to 44 per cent. while with benzene it is about 13 to 15 per cent. It must be mentioned that the smaller the volume of the lower layer, the greater the efficiency of the process.

N. Srinivasan.

Distillery, M.S.Co., Ltd.,
Mandya,
March 20, 1941.

[1] *Chimie and Industrie*, 1930; *I.S.J.*, 1930, p. 77.
[2] Sydney Young, *Distillation Principles and Processes*, pp. 177–180.
[3] *Ibid.*, p. 179.

AN IDEAL PRESERVATIVE FOR SUSPECTED WASHES

In cases of seizure of suspected washes, the plea often put up by the accused is that the wash seized is not really a fermented wash and that the alcohol detected has been formed after seizure due to use of an ineffective antifermenting agent. It was therefore thought desirable to study carefully the antifermenting properties of various preservatives commonly used for this purpose. In the United Provinces, Bengal and Bihar, 25 grains of salicylic acid are generally added to every quart bottle of suspected wash to arrest further fermentation.

Experiments were first carried out (under conditions similar to those used in actual practice in Excise cases) to test the power of arresting further fermentation of partially fermented washes of the following preservatives:

(1) Salicylic acid. (2) Benzoic acid. (3) Formic acid. (4) Mercuric iodide in potassium iodide solution. (5) Ammonium fluoride.

The results of some of these experiments are given in Table A. The table shows that formic acid and ammonium fluoride are not suitable preservatives for checking further fermentation while salicylic acid, benzoic acid and mercuric iodide in potassium iodide are quite suitable for the purpose. Experiments were also done under varying conditions, *e.g.*, (i) in different seasons of the year, (ii) with mahua flowers as base, (iii) with addition of yeast food, but results similar to those given in Table A were obtained in every case.

In another series of experiments, 72 washes (still containing fermentable sugars) were reexamined 1 to 6 months (12 after 1 month; 12 after 2 months; 12 after 3 months; 12 after 4 months; 11 after 5 months and 13 after 6 months) after their receipt in this laboratory. The washes were of different strengths and had been received in connection with excise cases and contained sufficient quantity of salicylic acid (*i.e.*, 25 grains per quart or more). In none of these cases had the alcoholic strength increased appreciably, but in 5 of these cases the alcoholic strength had slightly diminished due to acetic fermentation. These results show that salicylic acid is quite a suitable preservative for arresting the further alcoholic fermentation of partially fermented washes received in excise cases.

We next directed our attention to the study of the action of the preservatives on unfermented sugar solutions. It had been noticed in this laboratory that when unfermented cane juice or gur solutions were left for some time without the addition of any yeast, appreciable amounts of alcohol were formed. Thus it was found in a set of 18 experiments that the alcoholic strength went up to 2 to 6% of proof spirit in 10 cases and to 6 to 13% of proof spirit in 5 cases. These differences in alcoholic strength are probably due to the differences in quantity and nature of yeast *naturally* present in the original cane juice and gur solutions. An ideal preservative should, therefore, not only prevent the further fermentation of partially fermented solutions but also of unfermented sugary solutions. Tables B and C show the course of fermentation of unfermented

TABLE A

Showing the percentage of proof spirit formed during a period of six months after the addition of peservatives to partially fermented Gur solutions

Concentration of Gur solution before fermentation	35%				25%					
Preservative used (25 grains per quart bottle of 20 fl. ozs. capacity)	Salicylic acid	Benzoic acid	Mercuric iodide in KI	No preservative	Salicylic acid	Benzoic acid	Mercuric iodide in KI	Formic acid	Ammonium fluoride	No preservative
Starting day ..	12·3	12·3	12·3	12·3	7·9	7·9	7·9	7·9	7·9	7·9
After 15 days ..	12·3	12·3	12·3	24·7 (Maximum)	7·9	7·9	7·9	7·9	7·9	10·2
,, 30 ,, ..	12·3	12·3	12·3		7·9	7·8	7·8	9·2	7·9	16·8 (Maximum)
,, 45 ,, ..	12·3	12·3	12·3		7·9	7·8	7·8	9·8	7·9	
,, 60 ,, ..	12·3	12·3	12·3		7·8	7·8	7·8	12·1	7·9	
,, 90 ,, ..	12·2	12·2	12·2		7·8	7·8	7·8	14·4	9·5	
,, 120 ,, ..	12·2	12·2	12·2		7·7	7·7	7·7	15·6	11·4	
,, 150 ,, ..	12·1	12·1	12·1		7·7	7·7	7·7	16·1	15·1	
,, 180 ,, ..	11·8	11·7	11·8		7·7	7·7	7·7	16·2	15·2	

Concentration of Gur solution before fermentation	15%					10%				
Preservative used (25 grains per quart bottle of 20 fl. ozs. capacity)	Salicylic acid	Benzoic acid	Mercuric iodide in KI	Formic acid	No preservative	Salicylic acid	Benzoic-acid	Mercuric iodide in KI	Formic acid	No preservative
Starting day ..	5·4	5·4	5·4	5·4	5·4	4·3	4·3	4·3	4·3	4·3
After 15 days ..	5·4	5·4	5·4	5·4	8·4	4·3	4·2	4·3	4·3	5·4
,, 30 ,, ..	5·4	5·4	5·4	5·5	9·9	4·3	4·2	4·3	5·5	6·2
,, 45 ,, ..	5·4	5·4	5·4	6·7	10·8 (Maximum)	4·3	4·2	4·3	5·9	7·9 (Maximum)
,, 60 ,, ..	5·4	5·4	5·4	7·5		4·3	4·2	4·3	6·2	
,, 90 ,, ..	5·4	5·4	5·4	9·0		4·2	4·2	4·2	7·7	
,, 120 ,, ..	5·3	5·3	5·4	9·4		4·1	4·1	4·2	7·5	
,, 150 ,, ..	5·3	5·3	5·4	9·7		4·1	4·1	4·2	7·5	
,, 180 ,,	5·3	5·3	5·4	9·6		4·1	4·1	4·1	7·5	

Table B

Showing the percentage of proof spirit formed during a period of six months after the addition of preservatives to unfermented sugar solutions

Yeast added										
Nature and concentration of sugary solution taken	25% Gur solution				25% Gur solution with another sample of Gur			15% Gur solution		
Preservative used 25 grains of the acid or the acid equivalent per quart bottle of 20 fl. ozs. capacity	Salicylic acid	Salicylic acid	Benzoic acid	No preservative	Salicylic acid	Benzoic acid	No preservative	Salicylic acid	Benzoic acid	No preservative
Starting day ..	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
After 15 days ..	12·2	12·3	Nil	12·4	13·5	Nil	10·7	Nil	Nil	9·2
,, 30 ,, ..	16·4	17·3	Nil	11·4	19·2	Nil	13·8	5·3	Nil	10·1
,, 45 ,, ..	16·4	17·6	Nil	7·5	19·6	Nil	14·6	9·4	Nil	9·4
,, 60 ,, ..	16·4	17·0	Nil	7·6	19·5	Nil	14·4	10·6	Nil	6·3
,, 90 ,, ..	15·6	16·2	Nil	5·2	19·4	Nil	14·1	12·1	Nil	Highly acetic fermentation then developed
,, 120 ,, ..	15·6	16·2	Nil	4·8	19·3	Nil	14·1	12·1	Nil	
,, 150 ,, ..	15·4	16·1	Nil	4·5	19·1	Nil	8·4	12·1	Nil	
,, 180 ,, ..	14·7	15·2	Nil	3·9	18·3	Nil	7·8	11·9	Nil	

	Yeast added						Without added Yeast					
Nature and concentration of sugary solution taken	25% Mahua extract			25% Gur solution with another sample of Gur			25% Gur solution			25% Gur solution with another sample of Gur		
Preservative used 25 grains of the acid or the acid equivalent per quart bottle of 20 fl. ozs. capacity	Salicylic acid	Benzoic acid	No preservative	Sodium salicylate	Sodium benzoate	No preservative	Salicylic acid	Benzoic acid	No preservative	Salicylic acid	Benzoic acid	No preservative
Starting day	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
After 15 days	0·1	Nil	15·4	8·3	Nil	5·4	2·0	Nil	5·4	0·5	Nil	17·5
,, 30 ,, ...	9·2	Nil	15·2	15·4	Nil	10·4	6·8	Nil	7·1	0·7	Nil	16·9
,, 45 ,, ...	15·3	Nil	15·2	15·9	Nil	11·6	15·7	Nil	7·9	0·5	Nil	16·2
,, 60 ,, ...	17·2	Nil	15·1	15·9	Nil	11·6	15·6	Nil	7·9	0·5	Nil	16·1
,, 90 ,, ...	17·5	Nil	15·1	15·9	Nil	11·8	15·5	Nil	9·1	0·5	Nil	16·1
,, 120 ,, ...	17·2	Nil	14·9	15·8	Nil	10·4	15·4	Nil	10·4	0·5	Nil	16·0
,, 150 ,, ...	17·1	Nil	14·8	15·8	Nil	7·1	15·2	Nil	13·1	3·5	Nil	15·9
,, 180 ,, ...	16·9	Nil	14·6	15·5	Nil	6·7	15·2	Nil	13·5	3·8	Nil	15·7

TABLE C

Showing the percentage of proof spirit formed during a period of six months after the addition of preservstives in unfermented Gur solutions to which yeast had been added

Concentration of Gur in the solution before fermentation started	25%					15%		
Preservative used (25 grains per quart bottle of 20 fl. ozs. capacity)	Salicyclic acid	Benzoic acid	Mercuric iodide in KI	Formic acid	No preservative	Salicylic acid	Benzoic acid	Mercuric iodide in KI
Starting day ..	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
After 15 days ..	Nil	Nil	Nil	Nil	2·0	Nil	Nil	Nil
,, 30 ,, ..	2·4	Nil	Nil	Nil	4·0	Nil	Nil	5·9
,, 45 ,, ..	13·4	Nil	15·9	9·7	7·9	Nil	Nil	12·0
,, 60 ,, ..	13·8	Nil	16·1	18·5	10·2	Nil	Nil	12·5
,, 90 ,, ..	13·6	Nil	16·1	18·4	16·8 (Maximum)	Nil	Nil	12·6
,, 120 ,, ..	12·3	Nil	15·2	18·2		1·9	Nil	11·9
,, 150 ,, ..	12·3	Nil	15·2	17·8		2·8	Nil	11·9
,, 180 ,, ..	11·8	Nil	15·2	17·7		3·2	Nil	11·8

Concentration of Gur solution before fermentation started	15%		10%				
Preservative used (25 grains per quart bottle of 20 fl. ozs. capacity)	Formic acid	No preservative	Salicylic acid	Benzoic acid	Mercuric iodide in KI	Formic acid	No preservative
Starting day ..	Nil	Nil	Nil	Nil	Nil	Nil	Nil
After 15 days ..	Nil	1·5	Nil	Nil	Nil	Nil	1·0
,, 30 ,, ..	Nil	2·8	Nil	Nil	Nil	Nil	1·4
,, 45 ,, ..	0·5	5·4	Nil	Nil	Nil	0·4	3·1
,, 60 ,, ..	0·5	8·4	Nil	Nil	Nil	0·4	4·3
,, 90 ,, ..	0·5	9·9	Nil	Nil	Nil	0·4	5·4
,, 120 ,, ..	0·3	10·8 (Maximum)	Nil	Nil	Nil	0·4	6·2
,, 150 ,, ..	0·3		0·2	Nil	0·1	0·7	7·9 (Maximum)
,, 180 ,, ..	0·3		0·5	Nil	1·0	2·2	

sugary solutions (*with and without addition of yeast*) to which various preservatives had been added. It would be seen from these tables that benzoic acid alone prevents the fermentation

of unfermented sugar solutions and that salicylic acid is not a suitable preservative for this purpose. Benzoic acid (25 grains per quart) should therefore be used in place of salicylic acid for arresting further fermentation of suspected washes seized in connection with excise cases. When salicylic acid is used as a preservative, there is a possibility of miscarriage of justice in cases where unfermented sugary solutions are seized, for salicylic acid does not check the fermentation of unfermented sugary solutions containing active yeasts.

Finally, experiments were made to see whether smaller quantities of benzoic acid would check further fermentation of washes. It was found that even 15 grains of benzoic acid per quart effectively stop the fermentation of unfermented sugary solutions (and also completely check the further fermentation of partially fermented washes) for a period of 6 months.

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Agra,
March 23, 1941.

A NEW HOST—*RICINUS COMMUNIS*—FOR *LÉVEILLULA TAURICA* (LÉV.) ARN. [*OIDIOPSIS TAURICA* (LÉV.) SALM.]

During recent years the castor crop on the Central Agricultural Research Station, Coimbatore has been subjected to infection by an endophytic powdery mildew. The disease is prevalent in the months of November–March. The mildewy growth is mainly confined to the lower surface of the leaves (Fig. 1). In advanced stages of heavy infection white growths are present on the upper surface also in some places. Corresponding to the mildew areas on the lower surface, light green patches can be seen from the upper side especially when the leaves are held against light. The disease is absent on the youngest leaves at the ends of branches.

Fig. 1

Portion of a castor leaf (lower surface) showing powdery mildew.

The hyphæ are intercellular and occupy the spongy parenchyma of the mesophyll. Haustoria are produced and these penetrate into some of the parenchymatous cells. Conidiophores come out through the stoma in varying numbers. Branches develop from many of the conidiophores. Each branch produces one conidium at the tip. The conidia are hyaline and vary in shape, some having a tapering apex and others broad ends. Most of the conidia have a minute papilla-like projection at the broad end (Fig. 2*b*). They germinate readily in water producing a germ tube from one end and rarely from both ends (Fig. 2*c*). The spores measure on an average $67 \cdot 3 \times 18 \cdot 7\mu$. The ranges and their frequencies of the length and width of 200 conidia are given in the accompanying table.

The measurements and the distribution of the range agree with those of *Oidiopsis taurica*.

O. taurica has been observed on *Cyamopsis tetragonoloba*, *Capsicum annuum*, *Medicago sativa*, and *Vinca pusilla* from South India. *O. taurica* var. *macrospora* is present on *Dolichos*

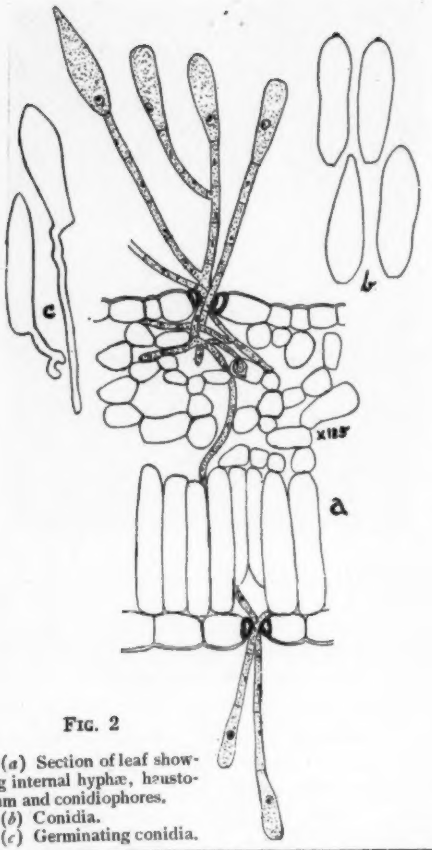

FIG. 2

(*a*) Section of leaf showing internal hyphæ, haustorium and conidiophores.
(*b*) Conidia.
(*c*) Germinating conidia.

Length		Width	
Class in μ	Frequency	Class in μ	Frequency
52·1—56	3	12—14·9	4
56·1—60	10	15—17·9	91
60·1—64	24	18—20·9	82
64·1—68	68	21—23·9	23
68·1—72	48		
72·1—76	39		
76·1—80	5		
80·1—84	2		
84·1—88	1		

lablab. But this is the first record of the fungus on castor.

T. S. RAMAKRISHNAN.
I. L. NARASIMHALU.

Agricultural Research Institute,
Lawley Road P.O., Coimbatore,
March 3, 1941.

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PYTHIUM APHANIDERMATUM (EDSON) FITZ. ON *CARICA PAPAYA*

EDSON[1] in 1915 described *Pythium aphanidermatum* as the cause of damping off of seedlings of sugar beets (*Beta vulgaris* L.) and radish (*Raphanus sativus* L.) in Wisconsin, U.S.A. Since then it has been reported on a variety of hosts from various parts of the world.

Vaughan[2] and Gardner[3] report a black rot of radish due to this species in Indiana, while Bunting[4] attributes to it the "damping off" of tobacco in Africa. Drechsler[5] describes a cottony leak of cucumbers (*Cucumis sativus* L.) caused by this fungus. He[6] also found it to be the causal agent of a cottony leak of *Solanum melongena* in Florida. In Sumatra Jochems[7] isolated it from Deli Tobacco. Tempany[8] mentions it causing a collar disease of tomato in Malay. Recently Tasugi and Takatuzi[9] report *Nematosporangium* (*Pythium*) *aphanidermatum* on *Phaseolus vulgaris* from Japan. Massey[10] describes this species attacking cotton in Sudan and Van Eek[11] on Pansy in Holland.

In India Subramaniam[12] ascribed a Pythium disease of ginger (*Zingiber officinale* Roscoe), Tobacco (*Nicotiana tabacum* L.) and Papaya (*Carica Papaya* L.) to *Pythium Butleri*. Due to its great similarity with *P. aphanidermatum* Carpenter,[13] Fitzpatrick[14] and Matthews[15] consider *P. Butleri* synonymous with *P. aphanidermatum*. Drechsler[16] makes a differentiation between *P. Butleri* and *P. aphanidermatum* on

grounds of dimensions and reproductive behaviour. Later on Mitra,[17] Sundararaman,[18] Ramakrishna Ayyar[19] and McRae[20] reported its isolation from various species of Cucurbitaceæ (*Opuntia dilleini*) and chilli (*Capsicum annuum* L.). Recently it was seen to cause a malodorous rot of water melon by Kheswalla[21] and a wet rot of tobacco seedling by Venkatarayan.[22] Galloway[23] mentions it on hemp.

Last year during the rainy season some "stem and foot rot" of Papaya trees (*Carica papaya*) was observed in an epidemic form in the Agricultural Institute Farm, Naini (Allahabad). Dr. E. F. Vestal, PH.D., Plant Pathologist of the Institute, isolated the fungus from the diseased stem by the usual method and kindly gave it to me for identification. Inoculations made by Dr. Vestal on healthy trees were partly successful. The patches caused by the fungus heal up in winter and inoculations made in the months of November and December did not show any sign of disease probably due to low temperature and dry weather. After studying the life-history the fungus was found to be *Pythium aphanidermatum* (Eds.) Fitz.

In artificial media the mycelium is well developed on corn-meal agar, bacto-peptone agar, bean agar and oat-meal agar. The hyphæ are aseptate, hyaline and with granular contents; irregularly and abundantly branched, varying in breadth from 2–5·8μ in diameter. Sporangia are formed in abundance when small tufts of aerial mycelium are cultivated for 4 to 5 days at 25° C. in a solution recommended by Petri.[24] They are filamentous composed of a lobulate inflated mass of branches with a long or short tube of discharge. They have also been observed on a solid medium (Bean agar). Number of zoospores varies from 4 to 30 in each sporangium. They are biciliate and bean-shaped. Oogonia are formed in abundance on oat-meal agar at 20° C. They are smooth, terminal, spherical and measure 18·9 to 28μ in diameter. Antheridia are single (rarely 2 to an oogonium) mostly intercalary, also stalked and terminal. Both hypogynal and diclinous conditions are to be found. Sometimes antheridia have a pointed beak. The oospores are smooth, round, thick-walled, not filling the oogonium, varying from 10·8 to 19·5μ in diameter.

Further work on the preventive methods of the disease is in progress.

The writer is indebted to Dr. R. K. Saksena for his valuable suggestions and guidance and his thanks are also due to Dr. E. F. Vestal for supplying the material.

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February 15, 1941.

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ECONOMICS OF MANURING

By P. V. SUKHATME, Ph.D., D.Sc., *Imperial Council of Agricultural Research*

IN a recent article[1] in the *Indian Farming*, Dr. W. Burns has raised two important questions regarding economic aspects of manuring, namely: 'Does manuring pay?' meaning thereby 'Does the money value of the additional crop exceed the price paid for the manure applied?', and 'what is the amount of manure that it would pay to apply?', given certain prices for manure and for produce. Dr. Burns has further stated that it would be advisable if the economic aspect of manuring crops was discussed with a precision that can be expressed in a table or a graph. The following method would appear to supply precise answers to the questions raised by Dr. Burns:

The appropriate statistical test to answer the first of the two questions is obviously the test of significance for profit which is the excess of the value of additional produce over the value of manure applied including the incidental charges of application, etc. For a given price of produce, the value of yield per plot is subject to the same experimental errors as the quantity of yield itself, so that if p is the price of produce per unit weight and u the error variance of yield per plot, the error variance of value per plot will be merely p^2u. The error variance of the mean value will be $\frac{p^2u}{r}$, r being the number of replications and that of the difference in mean values of manured over non-manured plots and hence that of the profit for a given price of manure will be $\frac{2p^2u}{r}$. The test of significance of profit is simply given by the quotient t of the profit by its standard error distributed in Fisher's well-known t distribution. If t is sufficiently large giving a large probability that profit as large or larger than the one observed would occur in future, it would indicate that manuring may be expected to pay for its cost. The whole validity of the approach follows by regarding the monetary value of yield rather than quantity as the measurable produce for manurial experiments. It is apparent that following the above approach a table or a graph or both can be readily constructed showing if it would pay to manure a crop at given prices for produce and for manure.

[1] W. Burns, *Indian Farming*, 1940, 1, 365.

The precise determination of the optimum dose of manuring presupposes a known form of relationship between the value of extra produce and the dose of manure applied. Field experiments rarely include more than three to four doses of manuring, which are obviously too few to provide an adequate indication of this relationship. It appears, however, reasonable to assume that a second-degree parabola of the form $v = a + \beta d + \gamma d^2$ with $\gamma - ve$, where v denotes value and d the dose of manure, would adequately represent the relation. It is a curve fairly extensively used to represent the relation in question and is clearly the one that common sense and facts support. The equation to the straight line giving the cost of manure is clearly $v = qd$, where q is the price per unit dose of manure. It will now be readily seen that the optimum dose is given by the point where the tangent to the value curve is parallel to the cost line for manure. In the notation used above the optimum dose d is given by $\frac{q-\beta}{2\gamma}$.

The standard-error of the optimum dose is readily derived. The value-curve can be alternatively written in the form

$$v = \bar{v} + b_1 \xi_1 + b_2 \xi_2$$

where $\bar{v}$ is the average of observed values, ξ_1 and ξ_2 are the orthogonal functions of d given by

$$\xi_1 = d - \bar{d} \text{ and } \xi_2 = \xi_1^2 - \frac{n'^2 - 1}{12}$$

and b_1 and b_2 are constants whose values are determined by the usual method of fitting a multiple regression equation. The sampling errors of b_1 and b_2 being clearly independent, the variance of the optimum dose is simply given by the variance of $\frac{q - b_1}{2b_2}$ which appears to be

$$\sigma^2 \left\{\frac{(\hat{d} - \bar{d})^2}{S(\xi_2^2)} + \frac{1}{4} \cdot \frac{1}{S(\xi_1^2)}\right\}.$$

The profit to be expected for any given dose of manure is clearly given by the ordinate of the value curve. It follows from what has been given above that its variance is simply the variance of $\bar{v}$ plus the quantity

$$\sigma^2 \left\{\frac{\xi_1^2}{S(\xi_1^2)} + \frac{\xi_2^2}{S(\xi_2^2)}\right\}.$$

The method outlined above has been illustrated in detail in an article to be published in the *Indian Journal of Agricultural Science*.

PURIFICATION AND CHEMICAL NATURE OF RENNIN

BY

C. N. BHIMA RAO, M. V. LAKSHMINARAYAN RAO, M. S. RAMASWAMY AND V. SUBRAHMANYAN

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IN recent years, a number of attempts have been made to prepare integrally pure rennin and to establish its chemical nature. Among these, special mention should be made of the work of Fenger,[1] who obtained a preparation which was nearly free from pepsin and contained 14·0 per cent. nitrogen and 0·7 per cent. phosphorus; Lüers and Bader[2] whose product was over seven times as active as that of Fenger, but showed distinct peptic activity and contained only 0·68 per cent. nitrogen; Tauber and Kleiner[3] whose best preparation contained no pepsin and gave the following percentage composition: carbon, 61·3; hydrogen, 7·02; nitrogen, 14·4; phosphorus, nil; chlorine, nil; sulphur, 1·19; and ash, 0·4. The last authors admit the possibility of their preparation containing an impurity of high nitrogen content but conclude, tentatively, that the enzyme is a thioproteose.

The present enquiry was undertaken with the object of throwing some light on the nitrogen status of the enzyme and to obtain some fresh evidence regarding its chemical nature.

The procedure adopted by us for the initial purification of the enzyme from calf stomach mucosa is based on the following findings:—

(1) On allowing ground mucosa to stand with 0·04 N HCl for 18 to 24 hours, an active extract is obtained which can be dialysed overnight without any appreciable loss of activity. During this dialysis, there is the separation of mucilaginous precipitate which carries down the major part of the enzyme. From this precipitate, the enzyme can be easily extracted in a concentrated form. The following is an example:

Acid extract of mucosa (obtained after standing for 24 hours. 50 ml. : 4 units* per ml.)

dialysed overnight against water and then centrifuged

Precipitate | Supernatant (14 units*)

Precipitate: extracted with 5 ml. of 0·04 N HCl and centrifuged

Precipitate (*Ca* 4 units*) | Supernatant (188 units* 37·6 units* per ml.)

By using more dilute acid than the above, the enzyme can be extracted out of the mucilage in a number of small fractions of varying degrees of purity.

(2) On adjusting the acid extracts as obtained in (1) to pH 5·4 (when a fine precipitate forms) and centrifuging the resulting suspensions, clear supernatants at higher levels of purity (as determined by the ratio of nitrogen to activity) than the starting materials can be obtained. The following is an example:

* The unit of enzyme as adopted by us may be defined as that required to clot 10 ml. of a 30 per cent. solution of 'Klim' whole milk powder in 0·3 M acetate buffer of pH 4·6 in one minute at 37°. This unit is roughly 15 times and in some cases 30 times, that adopted by earlier workers and was necessitated by the high activity of our preparations and the need for obtaining quick, reproducible and sharp clots. Where comparisions with earlier observations are necessary, the results have all been computed on the same basis.

Extract of mucosa (24 hr. old
3 units per ml. : total Ca 1600 units)

dialysed overnight and centrifuged

Precipitate (1300 units)

Supernatant (1·4 units per ml.
(rejected) 424 μg. of N per unit)

washed twice with water on the centrifuge

Precipitate

Supernatant (2 units per ml.: 15 ml.
(rejected) 183·4 μg. of N per unit)

extracted with 75 ml. of 0·01 N HCl and centrifuged

Precipitate (mostly insoluble,
70 units. Rejected)

Supernatant (6·6 units per ml.
19 μg. of N per unit)

adjusted to pH 5·4 with saturated Na_2HPO_4 and then centrifuged

Precipitate

Supernatant
(70 ml. : 1·4 units per ml.
23·5 μg. of N per unit)
Rejected

Extracted with 0·02 N HCl and centrifuged

Precipitate
(small and inactive)
Rejected

Supernatant

adjusted to pH 5·4 and centrifuged

Precipitate

Supernatant (43 ml. : 3 units per ml.
7 μg. of N per unit)

Extracted with 0·02 N HCl, adjusted to pH 5·4 and centrifuged

Fractionation continued in the above manner until a level of 2–3 μg. per unit was attained.

The next step in the purification was based on the observation that the mucilage (obtained on dialysis) can be repeatedly extracted with acid and reprecipitated at pH 5·4 until it is free from enzyme. It can then be used for adsorbing the enzyme, preferentially, from the associated nitrogenous impurities. Example:

Enzyme (100 ml. : 12 μg. of N per unit
2 units per ml.)
+
Mucilage (enzyme-free)

allowed to stand overnight against water in cellophane bag, then dialysed against running water for 2 hrs. followed by centrifuging

Precipitate

Supernatant (Inactive)

extracted with 0·04 N HCl, adjusted to pH 5·4 and centrifuged

Supernatant (4 units per ml.
1·0 μg. of N per unit)

Precipitate

extracted with acid and reprecipitated at pH 5·4

Operations thus continued

By extending the above operations, fractions containing even less than 1 μg. of N per unit were obtained, but the yields in such cases were generally small, totalling only 5 to 10 units in each case.

Considerable amount of purification can be effected by merely following a process of successive acid extraction followed by dialysis. Example:

The preparation keeps tolerably well when maintained out of contact with air and in the cold. At the ordinary temperature (25 to 35°), the activity is rapidly lost. At this

24 hr. extract of mucosa (12 units per ml.)

dialysed overnight and centrifuged

Precipitate

Supernatant (6 units per ml.)
(Rejected)

washed twice with water and centrifuged

Supernatant (30 ml. : 20 units per ml.)
(Rejected)

Precipitate

extracted with 0·04 N HCl, dialysed for 6 hrs. and centrifuged

Supernatant (6·7 units per ml.
3·1 μg. of N per unit)

Precipitate

re-extracted with acid and dialysed

Operations thus continued

By continuing the above series of operations, enzyme preparations at as low a level as 1·4 μg. of N per unit have been obtained.

It may be mentioned, however, that the above procedure is slow and tedious. It involves considerable wastage of enzyme. It is not therefore recommended except for certain types of preparatory work wherein phosphate-free enzyme is required.

Properties of the enzyme at 1·0 μg. (per unit of N) level.—The enzyme at this level gives a water clear solution which does not form a precipitate either on heating or on addition of trichloracetic acid. On drying, it gives a pale yellow solid corresponding 30 μg. per unit. Calculated on the same basis of activity, this would be approximately 9 to 10 times as pure as Tauber's in regard to nitrogen and nearly twice as pure in regard to dry weight.

There is a peculiar feature in regard to the ratio of dry weight to nitrogen. Even assuming that the nitrogen formed a part of the enzyme, there is a strong suggestion that the preparation contains a non-nitrogenous impurity. This can be confirmed both after short period dialysis and on allowing the preparation to stand for some time, when some of the non-nitrogenous impurity is deposited without appreciably altering the activity of the preparation.

The preparation does not respond to most protein tests, while, in a few cases, the colouration is faintly positive.

Tests for sulphur, pepsin and carbonic anhydrase were negative.

level of purity the enzyme does not lend itself to concentration by the usual freezing and desiccation methods. The major part of the enzyme is lost during concentration. The preparation can be dialysed against water for a short period without appreciable loss of activity.

Relation of nitrogen to enzyme.—There was considerable amount of indirect evidence to suggest that the nitrogen associated with the enzyme at different stages was an impurity:

(1) When the mucilage containing the enzyme was extracted with successive portions of dilute acid of the same strength (*e.g.*, 0·01 N HCl) and centrifuged after adjusting to pH 5·4, the quantities of nitrogen present in the different extracts were more or less the same and practically independent of the amount of enzyme (as shown by activity) present in each fraction.

(2) On mixing the enzyme at a high level of purity (1–2 μg. of N per unit) with a small amount of enzyme-free mucilage and centrifuging the suspension, all the nitrogen was left in the supernatant, while practically all the activity passed into the precipitate. This could not have occurred if the nitrogen were a part of the enzyme molecule.

(3) Filter aids (*e.g.*, Celite 501) adsorbed practically the whole of the enzyme leaving the nitrogen in the supernatant.

(4) Alumina C_γ adsorbed the enzyme

preferentially (25 : 1 when mixed with a preparation at 12·5 μg. of N per unit level) leaving the major part of nitrogen in the supernatant. Adsorption on kaolin also gave a similar result.

In none of the above cases was it possible to elute the enzyme successfully. Thus, the muco-protein of the mucilage always tended to dissolve to some extent (1·5 – 5·0 μg. of N per ml. depending on concentration of reagents) when extracted with dilute acid and precipitated at pH 5·4; the enzyme could not be eluted from celite and kaolin; phosphate buffer (pH 7·0 to 7·2—a more alkaline buffer could not be used because of its adverse effect on the enzyme) eluted the nitrogen preferentially from alumina C_γ leaving the major part of the enzyme in an unextractable condition.

Tricalcium phosphate proved a more promising material. It adsorbed both the enzyme and nitrogen, when used as aqueous suspension, but showed considerable preference for the enzyme when used in the partially dried, solid condition (the reason for this is still not clear). Elution with buffers proved inefficient, so the entire adsorbate was dissolved in acid with satisfactory results. Example:

The above observations have since been repeated a number of times and on a large scale. An essential condition for success seems to be the presence of an electrolyte (*e.g.*, phosphate in the present case) which apparently checks the adsorption of nitrogen by the tricalcium phosphate.

There has been some difficulty in estimating the true dry weight of the nitrogen-free enzyme. This is partly due to the difficulty in removing the last traces of tricalcium phosphate. Indirect evidence already obtained would suggest that the true dry weight is less than 10 μg. per unit.

The enzyme at the highest level of purity is extremely labile. The activity drops by about 75 per cent. in the course of a day. Experiments on the stabilisation of the pure enzyme and the study of its various properties and kinetics of reaction are in progress.

Reversible inactivation of rennin and the evidence for the existence of a thermostable component in the enzyme.—Extensive series of experiments were carried out on this aspect of the problem and the more important findings may be summarised as follows:

(1) Although rennin is rapidly and irreversibly inactivated at pH 8·0 and above,

Enzyme solution (10 ml. : 91 units
32 μg. of N per ml.)

adjusted to pH 5·4 and adsorbed on two successive lots of $Ca_3(PO_4)_2$ (0·1 g. each)

Supernatant

adjusted to pH 3·0 and adsorbed on $Ca_3(PO_4)_2$ (0·1 g.)

Precipitate (1) 30 μg. of N
(2) 21 μg. of N
(both inactive)

Supernatant
(2·2 units per ml.
270 μg. of N in all)

Precipitate

washed twice with water and then dissolved in 15 ml. of 0·08 N HCl and centrifuged

Supernatant
(2·6 units per ml. : 39 units)
NO NITROGEN

Precipitate
(Inactive. Rejected)

The determinations of nitrogen were ordinarily carried out by a micro-kjeldahl method followed by titration, but in cases like the above, each figure was checked, in replicate, by colorimetric estimation, the values being correct to 0·1 μg. The results show conclusively that the adsorbate obtained at pH 3·0 contained enzyme which was completely free from nitrogen.

it does, nevertheless, undergo a slow and reversible type of inactivation in the region of pH 7·0 to 7·4. The latter type of inactivation can be arrested by adding sufficient acid to adjust the reaction to pH 2·0.

(2) On adding a small portion of boiled enzyme or autolysate of mucosa to partially inactivated enzyme as obtained in (1), a

considerable part of the original activity is restored. This would suggest the presence of a thermostable component in the enzyme.

(3) A number of known substances were examined with a view to determining whether any of them can replace the thermostable component, but, so far, only zinc salts have been found to possess that property.

The following results will illustrate the above:

	Substrates 20% milk	30% milk
1. Partially inactivated enzyme alone	4' 30"	6' 20"
" + boiled enzyme	2' 40"	4' 15"

Original enzyme clotted in 1' 20". Boiled enzyme alone had no clotting effect.

	30% milk
2. Partially inactivated enzyme alone	7' 30"
" " + autolysate from mucosa (boiled)	2' 35"

Original enzyme clotted in 1' 30". The autolysate (boiled) had no clotting effect.

	30% milk
3. Partially inactivated enzyme alone	6' 30"
" + $CaCl_2$ (1 drop 1%)	> 7'
" + $CdSO_4$ "	> 7'
" + $MgSO_4$ "	> 7'
" + $SnCl_2$ "	> 7'
" + $ZnCl_2$ "	2' 30"

Original enzyme clotted in 1' 20". None of the salts (at the concentration used) had any direct effect on the milk. It may be further added that contrary to the report of Andreitchewa,[4] zinc at the concentration used has no effect on fresh rennin (before inactivation) and that the restoration is observed only in the case of the partially inactivated enzyme.

The above and similar experiments (which were repeated dozens of times) were carried out under identical conditions and with the necessary controls. These will be described in a detailed paper.

Some of the properties of the thermostable component.—It is stable in moderately acid or alkaline media; withstands prolonged boiling but is fairly rapidly lost on dialysis; present in the enzyme preparations at all levels of purity so far tested; mostly lost or otherwise transformed during prolonged evaporation, aeration or distillation under reduced pressure; inhibited in its action by sodium chloride and other salts in high concentration. It behaves generally like a co-enzyme.

Possible relation of ascorbic acid (vitamin C) to rennin.—Some of the properties of the enzyme, *e.g.*, instability in alkaline media, and sensitiveness to air and mild oxidising agents (*e.g.*, iodine), suggested some resemblance to ascorbic acid, hence attempts were made to determine whether it contained any of that vitamin. This was, in fact, found to be the case, the vitamin being present exclusively in some combined condition in all the preparations (including the nitrogen-free enzyme) in the proportion of about 0·10 μg. per unit.

It is not yet possible to state whether the vitamin is present as a part of the enzyme molecule or is associated with an impurity, still present in the final stages, but in view of its possibly great practical importance, the above observation is now being carefully followed up.

Chemical nature of rennin.—The foregoing observations suggest that rennin is probably a less complex substance than has hitherto been assumed. The absence of nitrogen, sulphur or phosphorus greatly restricts the scope of the enquiry. The purest enzyme is now being prepared on a sufficiently large scale to facilitate the study of its elementary chemical composition, which is probably made up of only carbon, hydrogen, oxygen together with some mineral constituents. The properties and behaviour of the thermostable component would suggest that it is something very similar, if not, identical with zinc. (Zinc has already been found at various levels of purity, though the quantitative data require confirmation). If the presence of combined ascorbic acid is conclusively established, it would point to a definite rôle for that vitamin not only in rennin but also in other similar enzyme systems.

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2 Lüers, H., and Bader, J., *Biochem. Zeit.*, 1927, **190**, 122.

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4 Andreitchewa, M., *Bull. Soc. Chim. Biol.*, 1930, **12**, 44.

REVIEWS

Anti-Mosquito Measures with Special Reference to India. Fifth Edition. By Lt.-Col. G. Covell, I.M.S. *Health Bulletin No.* 11, Malaria Bureau No. 3. (Manager of Publications, Delhi), 1940. Pp. 56. Price As. 8 or 9*d*.

This small bulletin deals in a concise but useful manner with the essential features of the modern methods of mosquito control. When it is realized that mosquitoes and the diseases transmitted by them can be controlled by more than one method, it becomes evident that the choice of method in any particular situation needs careful consideration. It is not possible, within the compass of this small bulletin of fifty-six pages, to go in detail into the intricate technicalities of the different aspects of mosquito control. But it is possible first to describe briefly most of the well-tried and accepted methods and then to indicate briefly under each method its merits and limitations. The author has very successfully done this, and consequently the bulletin presents a balanced description of the several methods of mosquito control now in use. Some of the latest developments, such as spray-killing adult mosquitoes, dustless method of applying paris green, etc., are included as also a fine chapter on naturalistic methods.

T. R. R.

Farm Animals, Their Breeding, Growth, and Inheritance. By John Hammond. (Messrs. Edward Arnold & Co., London), 1940. Pp. viii + 199. Price 14*sh*.

The book *Farm Animals* by John Hammond, which is based on two lectures given by him contains a brief sketch of the latest advances in the study of the scientific principles governing the genesis, growth and reproduction of farm animals, such as horses, cattle, sheep, pigs and poultry. The book is divided into two parts. The first deals with the principles of utility and growth of live-stock and poultry and the second, with those relating to genetics. In a small book of this kind it is only natural that the subject is dealt with in a very brief manner, only touching upon the latest advances in the science of genetics.

Under Part I, breeding seasons of the different animals, their fertility and sterility and artificial insemination are dealt with briefly and under Part II, the principles of heredity, the effects of selection and environment and other special problems in breeding for commercial utility are briefly outlined. The book is very well illustrated, but what is more important, it contains at the end a list of references which would be very valuable for collecting more detailed information on the subjects referred to in the book.

B. T. N.

Insect Pests in Stored Products. By H. Hayhurst. (Chapman and Hall, Ltd., London), 1940. Pp. 83 + 48 plates. Price 5*sh*. net.

This publication is in the nature of a handbook of 83 pages with numerous photographs of insects that infest stored products, brief notes on them and a list of substances and their pests for ready reference. In describing the insects, the orders are first referred to, then the families; the individual insects are then described. The book is written for the benefit of laymen, millers and store keepers. The treatment is not rigorously scientific. Entomological notes are rather loosely given and some of the technical conventions observed in entomological publications are overlooked. Thus the names of the insects are not authenticated by including the authors' names except in the case of those insects which are illustrated in the book.

In the list of substances and pests at the end of the book we find the following under substances: *Ephestia* (a moth), *Mites,* Plodia (a moth), *Tyroglyphidæ* (mites); and the following under pests: *Microbracon, Lyctocoris, Chelifer*!!

As a handbook for millers and store keepers, the book may prove useful. One would have wished for a more satisfactory treatment of the subject both with regard to the insect pests and the methods of pest control.

T. V. S.

ANNALS OF PHYSICS: RECORD OF A YEAR'S ACHIEVEMENTS

Reports on Progress in Physics, Vol. VI, 1939. Edited by J. H. Awbery. (Published by the Physical Society, London), 1940. Pp. vi + 434. Price to non-Fellows 22*sh*. 6*d*. net.

WHEN one surveys the enormous output of scientific literature bearing on even circumscribed fields of knowledge, one is appalled at the task of sifting all this and choosing what one absolutely needs if one is to play an intelligent part in life. Even a devoted worker in a given field must find some time to discover how some advance in another field affects the prospects of success in his chosen subject. He cannot generally wait till an authoritative account appears in the form of a book, or, even if he waits, the particular detail that would be useful to him may not be found in the book. Thus arises the problem of providing periodical surveys of recent progress so as to serve the needs of one who has not specialised in the particular field surveyed. This problem has been tackled in a variety of ways and each solution has its own usefulness. In the first place, we have the abstracting Journals such as, for Physics, *Science Abstracts*, Section A, *Physikalische Berichte*, *Journal de Physique*, Section D, etc. If possible, one should consult these and make a list of the references bearing on the problem in hand. However, this procedure is not always possible to pursue. Then one can consult such articles as appear in *Die Physik* where a summary of all the literature bearing on selected topics is given. When one lacks either the time or the knowledge requisite to make one's own list of references, one has to turn to an account by an expert such as one finds in the articles in *The Reviews of Modern Physics* or the *Physikalische Zeitschrift*. When an account is needed which will serve the non-specialist reader, one should turn to the articles appearing in such Journals as *Science Progress, Nature, Die Naturwissenschaften, The Journal of Applied Physics* and so on. On the other hand, when one desires to have an idea of the outstanding achievements in a given year, one now naturally turns to the *Reports on Progress in Physics* brought out by the Physical Society of London. These Reports have now established a place for themselves in a Physicist's Library and the present book, *viz.*, Vol. VI of these Reports fully satisfies the expectations that one has formed from a knowledge of the previous volumes of the series. In a way the articles in the Report partake of some features characteristic of the various Journals we have mentioned above. Thus we find a similarity to *Science Progress* in some articles which deal with all the work done in a given field such as those on 'Sound' by E. G. Richardson, and 'Heat' by R. W. Powell. The article by Richardson is indeed a model of what such a survey should be. There are articles on specialised topics like "Induced Radioactivity" by the late H. J. Walke, "Separation of Isotopes" by H. C. Urey and "The Meson" by Peierls, which are reminiscent of *The Reviews of Modern Physics*. Some articles on applied physics like "Fluid Motion" by A. Fage, "Kinetic Theory of the Elasticity of Rubber" by H. Pelzer, "X-Rays and Crystals" by J. M. Robertson, W. H. Taylor, H. Lipson and E. T. Goodwin, remind one of the *Journal of Applied Physics*. The bibliography at the end of the articles reminds one of *Die Physik*. Many of the articles can certainly be followed by non-specialists, but, though the whole book is meant for such readers, it is doubtful if one can make good use of some articles like those on "The Physics of Stellar Interiors and Stellar Evolution" by H. A. Bethe and R. E. Marshak, "The Theory of Molecular Structure" by W. G. Penney, or "The Magnetic Effect in Diatomic Spectra" by M. H. Crawford, without a rather good knowledge of the subject to start with. Many of the contributors are certainly masters in their several fields and their articles carry the authoritativeness we should expect from them, but it is not always that we find that simplicity, freshness and attractiveness which is characteristic of some articles in such Journals as the *Bell System Technical Journal* or *The Journal of the Franklin Institute* or *Die Naturwissenschaften*. The Editor says that "the proportion of matters of topical interest has gradually been growing as experience and criticism have shown what was most needed", but from the point of view of a teacher of physics, we should welcome more surveys like that of E. G. Richardson,

describing most of what has been done and at the same time giving a critical valuation of the work described. In another way, we should like to see more articles resembling those of Darrow in *The Bell System Technical Journal*, in order that the needs of a non-specialist may be more effectively met. The get-up of the book is excellent; in fact we have noticed only two misprints in the entire volume. The Physical Society is to be congratulated on publishing such a fine volume, fully up to the standards set by previous volumes, even under the stress and turmoil of a war that threatens the very foundations of civilisation. We hope that the success of the present book may be such that the Society will be able to present an even better volume for 1940. It is superfluous to add that no Physics Library should be without its copy.

T. S. SUBBARAYA.

THE OUTLOOK FOR WHALE OIL AND WHALING

Whale Oil: An Economic Analysis. By Karl Brandt. *Fats and Oils Studies*, No. 7. (Food Research Institute, Stanford University, California), June 1940. Pp. xii + 264. Price $3·00.

THE application of the process of oil hardening by hydrogenation about 1907 and the consequent increase in the industrial utility of whale oil led to the phenomenal expansion of whaling which reached its culminating point in 1931 when over 42,000 whales were taken and some 614,500 tons of oil produced. A large amount of this production remained unsold for a time; the surplus weighed on the market and contributed to the slump in oils and fats which reached its nadir in 1934. It became, indeed, usual for producers of vegetable oils and oilseeds to regard whale oil as the main cause of their economic difficulties, and moreover an interloper in the market.

Far from being a newcomer, whaling has of course a long and eventful history, which forms one of the most fascinating chapters of the story of world commerce. The work under review gives a good account of this history back to that ninth century Norwegian Othar, whose whaling narratives were recorded by Alfred the Great.

From about 1600 to 1859 Arctic whaling was pursued by several nations, in particular the Dutch, the British and the German Hansa ports, chief of which was Hamburg. The nineteenth century saw the peak of the prosperity of the famous American whaling industry in the 1850's. The products of these industries were whalebone, sperm oil and spermaceti, and whale oil. Sperm oil as a lubricant, spermaceti as a candle-making material, sperm and whale oils as illuminants could hardly survive the competition of petroleum products which developed after the middle of the nineteenth century, and it required the adaptation of whale oil for edible purposes by the hardening process already mentioned, to inaugurate the modern whaling era, which is largely an achievement of the Norwegians, and predominantly confined to the Antarctic.

Compared with the world's total production of oils and fats, which is estimated to exceed twenty million tons annually, even the 1931 peak production of whale oil is not considerable—say about 3 per cent.—and it is pertinent to enquire why this apparently small amount should have exercised such a disproportionate influence on the world's markets. A main point is that all the whale oil produced comes into the market, whereas a large proportion of other fats is consumed at source and is not exchanged for other goods or money. Reckoned as a percentage of the total foreign trade in fats, whale oil represents 9·4 per cent. and becomes nearly as important as butter (11·7 per cent.). It is also pointed out in the book under review that before the present war, utilization of whale oil was largely confined to Great Britain and Germany, the two leading fat importing countries.

In discussing the outlook for the future, the author concludes that from whale oil "no great new disturbance for the world's fat markets is to be expected". As far as the future of whaling itself is concerned, our present knowledge is insufficient to state exactly what rate of whale catching can be maintained without depleting the world's stocks. No new unknown seas remain for exploration and the limit of whaling must be in sight. The present volume gives an interesting discussion of all the factors

involved, with a fascinating excursus into marine biology and an account of British and Norwegian research. It is provisionally concluded that 450,000 to 500,000 tons is the maximum output that can be maintained. The history of international agreements in the past do not, however, give much hope for an effective whaling agreement in the future and it may be that there will occur fluctuating periods of excessive exploitation and enforced restriction.

This volume can be recommended as a well-documented and readable account of a subject which is by no means remote for vegetable oil producing countries like India and Ceylon; the very full statistical data are clearly presented in a number of charts and tables and the book is provided with an excellent bibliography, in which the reviewer is glad to see "Moby Dick"! One suspects that the author is indebted to Herman Melville's "Sub-sub librarian" at least for the reference to Othar the Norwegian, and for the title-page quotation from Thomas Fuller:

"The mighty whales which swim in a sea of water, and have a sea of oil swimming in them." (*Profane State and Holy State,* 1642.)

R. CHILD.

Coconut Research Scheme,
Lunuwila, Ceylon,
March 15, 1941.

CINCHONA CULTIVATION IN INDIA

BY

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THE production of quinine and the associated cinchona alkaloids in India has been the subject of repeated discussions during the last decade both in the legislatures and in the press. In a country, where malaria is the dominant problem in public health and a major cause of low economic efficiency, the question of an adequate supply of cheap quinine, along with that of preventive measures, is one of perennial interest.

The present position of quinine supplies in India is, without doubt, unsatisfactory. The minimum requirements of quinine in the country, as estimated by the public health authorities, are 600,000 lbs. per annum. The actual average consumption in the pre-War years has been estimated at 21,000 lbs. This enormous gap between the real or clinical demand and the effective or economic demand may be ascribed largely to the high price of quinine relative to the purchasing power of the country as a whole. The problem of a reduction of price is complicated by the fact that only a third of the present effective demand is met by production within the country. The foreign manufacturers, who supply the bulk of the Indian demand, are not particularly interested in a reduction of price, as this demand has not appreciably increased over a long period and continues to form only a small portion of the total world demand. There is a large market for quinine in Russia, the United States of America and the South American countries which can afford high prices. The Royal Commission on Agriculture in India, reported in 1925, that for India to embark on any large campaign for fighting malaria, it would first be necessary to reduce the price of quinine within the country, and this could be effected only if India were self-supporting in cinchona products.

One of the causes which may have delayed the expansion of cinchona cultivation in India is the fear of competition from Java which has great natural advantages in the growing of this exotic species. The risk of competition is not however as great as may appear. In the first place, the present standard of production in India with reference to yields and costs is certainly capable of improvement and, in the second place, there are still large tracts of land that should prove naturally suitable for cinchona. Java, moreover, is not likely to be greatly concerned about the Indian market until it expands very considerably to bear comparison with the world market.

Apart from purely commercial considerations, the quinine industry has a special interest in India. In spite of the many synthetic antimalarials put on the market in

recent years, quinine (together with other cinchona alkaloids) still holds the first place in the treatment of malaria. It is the one antimalarial which, having no pronounced toxic effects, may be administered under very simple instructions and without qualified medical supervision. It is also likely to be the cheapest remedy for a long time to come. Both these are important considerations in a country like India and quinine may well be regarded as an industry of national importance in which self-sufficiency should be the aim. The more so as, under present conditions, not only the price of quinine but also the regularity of its supply is affected by every world event which disturbs the normal courses of trade and commerce.

Public attention has again been drawn to these matters through the results, reported in 1939, of an enquiry by the Imperial Council of Agricultural Research into the prospects of cinchona cultivation in India. Mr. Wilson, the author of the report, deals exhaustively with the whole question from the historical, commercial and technical points of view. His main conclusions are:—

(*a*) that sufficient land, suitable for cinchona, is available in India to make the country largely self-supporting, (*b*) that in addition to undertakings by the Provinces and States, private planting interests should also be encouraged to grow cinchona as they are in possession of much suitable land, (*c*) that a comprehensive scheme of research should be undertaken with a view to increasing the efficiency and reducing the cost of production, and (*d*) that an organised scheme of distribution is an essential part of any forward campaign in production. To those who are interested in the development of cinchona production in India a careful perusal of this report would be worth the trouble. A reference may also be made, at the same time, to A. T. Gage's report of 1918 on the same subject.

Since the publication of the Wilson Report the Council have been engaged on the formulation of a scheme of research on cinchona references to which have been made in the press from time to time. Associated with a programme of work on fundamentals and on methods of cultivation there is also a proposal for the establishment of test plots in different parts of India and the provision of State nurseries to supply healthy young plants to new undertakings. As regards the actual extension of cultivation, the two Provincial Governments, who have hitherto been the major producers of quinine in India, have either adopted or are likely to adopt extended programmes of work. Other provinces with suitable land and some States, particularly those that had grown cinchona in the past, appear to be making preliminary investigations while the planting community, both in the north of India and in the south, are said to be willing to grow cinchona under certain conditions.

The two major factors involved in the development of the quinine industry in India are (1) an extension of areas under cultivation by various authorities in possession of suitable land and (2) an increase in the productivity of the land through careful research. An improvement in the methods of manufacture from bark to quinine need not be considered as of great importance at this stage, for the methods of manufacture practised in India have already reached a fairly satisfactory level of efficiency. In any case, further improvements in chemical and chemical engineering technique could be effected within a short time through intensive research. Extension of cultivation and research into the methods of cultivation would, however, take a relatively long period in producing results, as cinchona is not an annual crop but takes anything from 8 to 10 years to mature.

Of the two factors noted above, research, though not easy in itself, would be the simpler to organise. The problems of technique are more or less specific and capable of solution through the usual methods of scientific investigation. Research in cinchona requires the collaboration of geneticists, plant physiologists, organic chemists, soil chemists, horticulturists and statisticians. In every investigation the cost of application of positive results to the routine of cultivation should be a matter for special study and close contact will be necessary with the actual conditions of large-scale production. The problems that require attention are (1) the breeding of hardier and richer strains of cinchona, (2) the development of vegetative methods of propagation, (3) the conservation of soil and the maintenance and improvement of soil fertility, and (4) the adjustment of cultural operations and harvesting programmes to different local conditions. Long

range work is called for in some cases, while in others results may reasonably be expected within a few years. But in all cases there is need for systematic work and an early start. At least 70 per cent. of the cost of production of quinine lies in the wages of labour with regard to which there is obviously no room for economies. The major production units in India are already extensive enough to enjoy the usual overhead economies of large-scale production. A reduction of costs, therefore, can only come from an increase in the productivity of the land for which research is essential.

It is not however necessary that a programme of research should be carried through to conclusion before any extension of cultivation can be undertaken. Experience of cinchona is already available in India on which to base methods of cultivation suited to different local conditions and capable of giving results sufficiently economic in relation to world prices under normal trade conditions. Nor would it be feasible to postpone all increase of production until our methods are perfect. The need for more adequate local supplies of quinine is becoming urgent. Apart from the question of speeding up its consumption to the full limit of clinical requirements, there is an increasing pressure of current demand on Indian cinchona resources as a result of more progressive public health policies on the part of Provincial Governments, States and Local Authorities. It must also be remembered that the formation of new plantations will take time. Suitable areas will have to be decided upon, finances arranged, test plantations started, local conditions evaluated, production plans drawn up and workers properly trained in adequate numbers. It is therefore not desirable, as it is not necessary, that arrangements for an extension of cultivation should await the results of research on the improvement of methods.

Different views have prevailed from time to time as to the agencies that could best undertake the actual production of cinchona as distinct from research. The State, the industrialist and the small cultivator have all been suggested in turn as the most desirable agencies. The State agencies, namely, the various Governments both in British India and the Indian States, are directly interested in supplies of quinine. They consume large quantities through their medical and public health organisations and also assume certain responsibilities for supplies to local authorities under their administration. They have the greater portion of the total available resources in land, money and personnel. They would also require the minimum of inducement by way of net financial gain. The industrial agencies may be taken to consist mainly of the plantation interests and the manufacturing chemists and pharmacists. The former, in many cases, possess the land and capital and some practical experience; the latter might, in some instances, wish to acquire plantations but would, in the main, be probably content to confine themselves to the manufacture of quinine from bark produced by others. The immediate as well as the ultimate inducement to private enterprise would have to be more attractive than to State enterprise as the former would require more adequate returns on capital. As a cottage industry cinchona is likely to prove wasteful, for the small cultivator would be generally handicapped for want of technical knowledge and adequate resources and would, moreover, have frequent temptations of realising his assets before maturity. There has been some difference of opinion in the past as to the desirability of private enterprise in cinchona as compared to State enterprise, but considering the present distribution of control over the total resources in production, it is probable that both private and State agencies will have to come into the field before really adequate supplies of quinine are assured to the country.

This view is supported by a consideration of the average yield of quinine that may be expected from the Indian plantations. The yield, according to Mr. Wilson, may under present conditions be taken as 180 lbs. of quinine sulphate per acre over a period of 12 years. This is equivalent to 15 lbs. per acre per annum. To produce the estimated minimum requirement of 600,000 lbs. per annum it would, therefore, be necessary to have a crop-bearing area of 40,000 acres. This, however, does not represent the gross total of necessary plantation areas. A margin of cropable area must be allowed to ensure a periodic rest to the land under alternative crops. Land will also be required for the housing of labour and staff, for buildings and roads and for the production of subsidiary raw materials like timber and fuel and bamboo and thatch. Further,

most plantation areas, being in the hills, would naturally be interspersed with much waste land by way of streams, ravines, precipices and rocky or wet patches. It is not easy to make an estimate of the total gross area required, for conditions will vary from place to place. But 120,000 to 150,000 acres may be taken as a very approximate figure. Mr. Wilson's estimate of the available first class cinchona land is 38,000 acres. From the nature of his calculations this appears to represent the net cropable area as distinct from the gross area available for the formation of plantations. In spite of this and in spite of his mention of large tracts of second class land in various parts of India which under certain conditions it might be profitable to exploit, he is not at all happy about a sufficient margin of safety. He therefore suggests, though only indirectly, that steps should be taken to ensure the utilisation of all first class cinchona lands for growing this crop alone. This is a matter that deserves serious consideration.

Mr. Wilson has made an extremely helpful survey of the general land position. But the very importance of his conclusions requires it to be followed up by a more detailed survey with reference to localities, acreages, soils and climatic conditions. There is the need for a proper assessment of the second class areas mentioned by him, particularly those in Assam. There is also need for a grouping of the available areas into compact plantation units on an economic scale. Such a survey would require the co-operation of all who are in possession or occupation of suitable land and the proposed test plots could form the centres from which the technical portion of the survey might be undertaken.

A rational long-period policy for India as a whole can only be based on a complete knowledge of our ultimate resources, though the rate at which such resources could be developed would depend on circumstances. Even for individual production schemes of any appreciable size the preparation of efficient working plans requires the collection of data in greater detail than available at present. A broad co-ordination of regionally separate and economically independent schemes is not a mere counsel of perfection. If the distressing conditions that have overtaken many of the plantation industries in recent years are to be avoided in the case of cinchona, there is no doubt that production should be developed, from the earliest possible stage, on an all-India basis instead of through a multiplicity of competitive schemes. This is the more important in view of the fact that cinchona is a long period crop and any appreciable maladjustment of short period supply and demand would take time to correct itself resulting in considerable hardship to the producer or the consumer as the case may be.

Though there is no danger of an ultimate overproduction of cinchona in India, no production scheme can afford to be divorced permanently from the question of distribution. It must be remembered that the effective or economic demand in India is quite small at present and requires to be stimulated as much as production needs to be increased. This effective demand comes not directly from the malaria stricken population who are generally too poor to afford quinine at any price, but from the medical, public health and local authorities, who have certain responsibilities with regard to public welfare, as well as large employers of labour who find it paying to keep their workers in good health. It is to these that the cinchona industry in India must look for a proper development of consumption until there is an appreciable improvement in the general economic level of the country. A healthy co-relation of supply and demand will therefore depend, more on a deliberate co-ordination of production with all medical, public health and public activities against malaria than on the play of normal forces in trade and commerce. It is not difficult to visualise an organisation of producers, distributors and consumers for the regulation of the cinchona industry in India, each helping the others; but the initiative must come from a source of influence and prestige.

To turn from the ideal of a programme of balanced production and distribution, the immediate problem is a stimulation of production by inducing a number of potential undertakings to make a start. The present scarcity of quinine supplies which is likely to last for some time, together with the rising trend of consumption already mentioned, should be a strong incentive for action. Further incentive may be provided through well-informed propaganda. A very practical and effective form of it would perhaps be the establishment, on a regional

basis and under a variety of natural conditions, a number of model plantations which, run on commercial lines, should afford concrete examples of the possibilities of large-scale production. Some of the test plots, the maintenance of which is now under consideration of the Imperial Council of Agricultural Research, could form the nucleii of such model plantations. Both the test plots and the model plantations, which must necessarily be run with the utmost possible efficiency, would require the careful training of workers towards which a central research organisation should be able to render valuable help.

Every successful new undertaking will act as an incentive to others, but every failure is also likely to retard the general progress. It is therefore necessary that all possible precautions should be taken, specially in the early years, against the risk of failure through a lack of experience. This is the reason why Mr. Wilson proposed his State Nurseries, propagation being one of the most difficult things about cinchona cultivation. For the same reason there would also appear to be need for an advisory service to help newcomers in the field with choice of land, choice of species and other technical matters relating to the initial stages of forming a plantation. That such a need has already been felt is clear from the numerous enquiries that have recently come from various parts of India to the existing cinchona administrations. Proper attention to such enquiries is possible only for a special organisation with sufficient time and facilities at its command, and the idea of an advisory body, consisting of specialist research workers as well as men with practical experience of cinchona, naturally suggests itself.

India's need for adequate supplies of quinine is urgent. The times are favourable for the development of an indigenous industry. What would appear to be necessary is the formulation of a co-ordinated scheme of work and the pooling of all resources in its execution.

AQUARIUM AND MARINE BIOLOGICAL LABORATORY OF THE UNIVERSITY OF TRAVANCORE

BY

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IT has been the experience of many biologists, that facilities for researches on aquatic biology are very limited, if not entirely lacking in India. There is not a single institution in India which may be compared to the Biological Stations in Europe, America or Japan,[1] *i.e.*, a station where aquarium facilities are provided for the convenient study of physiological and bionomical problems relating to aquatic organisms. There are laboratories without aquarium facilities, and, aquaria without laboratory convenience. Owing to the lack of this essential combination, the Indian biological laboratories have been concentrating mostly on anatomical or histological problems, while the few existing aquaria have functioned purely as show places of a popular character. The gravest consequence of this state of affairs was that our fisheries have not benefited in any appreciable manner through the researches of our biologists. Our fisheries still continue in the primitive condition, in which they existed during the times of our forefathers hundreds of years ago, while the fisheries of Europe, America and Japan have progressed with rapid strides, through the incorporation of scientific knowledge and scientific experience in all branches of the industry. This handicap has compelled us very often to copy blindly the methods of other countries, without testing whether the adoption of such methods will suit our local conditions and requirements. Unlike other positive sciences, results of applied biological work carried out in one country may not be of any practical value to another country. For example, the life-history of the herring, cod or salmon or the method of artificial propagation of the white fish, grayling or shad may not help us to solve the problem of our sardines, mullets, seer fish or prawns. The study of the ocean currents, temperature, salinity and related oceanographical problems in other countries will not enable us

to draw inferences regarding these factors of our seas. Types of fish and their habits, nature of the sea and the organisms found therein vary according to geographical conditions, so that, if any country desires to develop its fisheries, it must organise its own scheme of researches. This necessity has long been felt and the profound scientific importance of a combined aquarium and laboratory for the convenient study of not only anatomical and physiological problems in aquatic botany and zoology, but also the habits and environments of marketable food fishes, has long been realised, and the opinion of scientific bodies was being slowly shaped towards the establishment of such an institution. It was at this juncture that the University of Travancore decided to organise a biological station to provide scope for the study of aquatic biology and fisheries.

Unlike any other locality which may be selected for the situation of such an institution, the site chosen for this laboratory is most ideally suited for the purpose in view, since it offers convenience for the study of not only marine biology but also every type of aquatic life, including brackish water and river fauna. The laboratory is situated at a distance of only 1,500 feet from the sea and in the vicinity of two important lakes and a river.

Two miles to the north of the laboratory is the backwaters of Veli and a few miles further north is another much larger backwater called Kadinumkulam lake. Both these backwaters are rich in fisheries and every type of brackish-water fauna, which may interest students of biology. About two miles to the south of the laboratory the Karamanai river flows into the sea, and a short distance further south is one of the few important freshwater lakes called Vellayani. For marine collections also Trivandrum is ideally suited. The laboratory has under its control a good seaworthy canoe and two experienced fishermen, who daily bring to the laboratory collections of plankton and fish. The pier at Trivandrum and the beautiful palm fringed promontory of Kovalam about two miles south of the pier, with scattered boulders and rocks jutting into the sea afford convenience for collections of every type. Thus it will be seen that every conceivable type of aquatic fauna is within easy reach of the laboratory, and in order to accommodate all these aspects of work both the aquarium and the laboratory provide the necessary facilities.

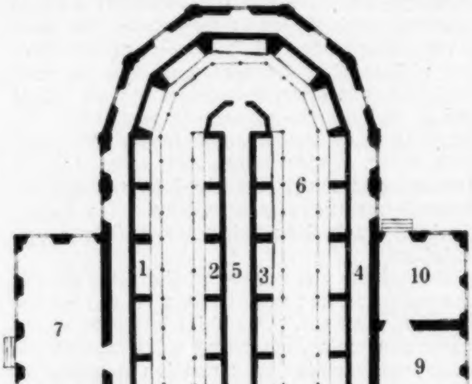
FIG. 1

General view of the Aquarium and Marine Biological Laboratory

THE AQUARIUM

The aquarium is situated on the ground floor of the building and it has been designed on the most up-to-date lines, incorporating all the latest improvements in aquarium construction. The entrance to the aquarium

is from a wide verandah 45′ by 18′ and in the centre of the facing wall of this verandah is a large bas relief figure of *Matsyavathar*, symbolising the slow emergence of the higher forms of life from aquatic ancestors, and imparting a somewhat religious atmosphere, which is harmonised by the general architectural design of the whole building.



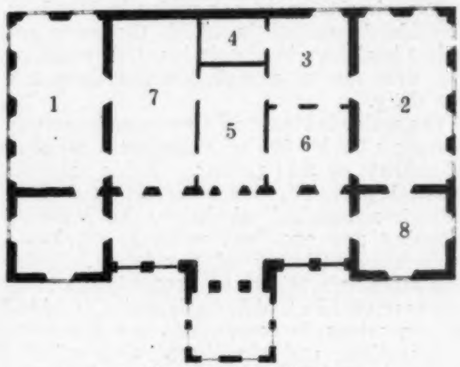
Plan of the Ground Floor

1. Sea water tanks. 2. Fresh water tanks. 3. Brackish water tanks. 4. Service corridor of sea water tanks, 5. Service corridor of Brackish and Fresh water tanks. 6. Visitors' corridor. 7. Curator's office and preparation room. 8 9 & 10. Office of the Department of Fisheries. 11. Stair-case room.

The aquarium hall is 75′ by 45′ and takes the form of a crescentic gallery 134′ long with tanks on each side. On the sides there are fifteen sea-water tanks while the central part is occupied by two parallel longitudinal rows, with seven tanks in each row.* Thus there are altogether twenty-nine tanks, of which all excepting six small tanks are meant for the display of rare and interesting forms of aquatic life.

The outer tanks are constructed 3½ feet away from the side walls of the aquarium hall, thus providing a continuous 'service corridor' for the sea-water tanks. A similar 'service corridor' is also provided between the two central rows of tanks, which are meant for fresh-water and brackish-water fishes respectively. This arrangement enables employees of the aquarium to attend to the tanks without causing inconvenience to the visitors.

The side and back walls of the tanks are constructed of reinforced concrete and plastered internally with blue cement mixed with water-proofing material, while the front of the tanks is fitted with 1-inch thick glass plates specially manufactured for the purpose by Messrs. Pilkington Brothers, England. Since variations in temperature during any part of the year are not very considerable, the glass plates have been



Plan of the First Floor

1. Junior laboratory. 2. Senior laboratory. 3. Chemical laboratory. 4. Photographic dark room. 5. Common room. 6. Library. 7. Fisheries industrial museum. 8. Office of the Professor of Marine Biology and Fisheries.

simply built into the concrete without any precautions against expansions or contractions. The upper edge of each glass plate is held in position by a reinforced concrete beam and from the top of this a wooden screen extends right up to the ceiling. This screen cuts off view of the service corridor from the visitors' gallery and also prevents light from the illuminating sources above the tanks from passing directly into the visitors' gallery. The visitors' gallery is not lighted as a rule, while the tanks are lighted from above from invisible sources. As a result of this arrangement the visitors get a series of brightly illuminated pictures of the under water world, but apart from this scenic effect it also satisfies an essential condition in the proper care of fishes.

The inner surface of the wooden screens, the walls and ceiling of the aquarium hall are all painted light blue, while the outer surface of the screens, i.e., the surface facing the visitors' gallery is painted with a series of submarine sceneries, depicting rare and

* The last tank in each central row is divided into smaller tanks, not shown in the figure.

interesting varieties of fishes and other marine forms of life in their natural surroundings and colour.

The visitors' gallery is 15 feet wide and is bounded on each side by barrier rails, which have been provided for the safety of the glass plates. The total capacity of the fifteen sea-water tanks is 12,600 gallons while the combined capacity of the brackish and fresh-water tanks is 8,400 gallons. Thus it will be seen that both in regard to size, number of tanks and their total capacity this aquarium is the largest on the mainland of the Asiatic continent.

Circulation of Sea Water

The circulation of sea water is based on the Lloyds system in which the same sea water is always in circulation, thus avoiding the necessity of pumping water from the sea daily.

Sea water is stored in a large underground reservoir 35′ by 25′ by 8′ having a capacity of about 49,000 gallons. By a median vertical partition, this reservoir is divided into two longitudinal halves to facilitate cleaning any one half without interfering with the continuity of circulation. From this main reservoir water comes into a mixing reservoir in which fresh water is added to sea water to compensate for losses by evaporation and to keep the salinity constant. Originally it was planned to connect an evaporimeter above the rows of tanks to determine the quantity of fresh water to be added, but as this was not available, owing to the present international situation, addition of fresh water is effected by calculating the salinity of sea water in the tanks at regular intervals.

From the mixing reservoir a 5-inch cast iron suction pipe, fitted with a foot valve, leads into the pumping set. The housing and impeller of the pump, with which sea water comes into contact, are made of hard phosphor bronze, while the delivery pipe is of cast iron. This delivery pipe discharges into a reinforced concrete overhead reservoir 18′ by 12′ by 8′ with a capacity of about 9,000 gallons. From this reservoir water is led into the aquarium hall through 4-inch asbestos cement pipe, which is tapped at regular intervals above each aquarium tank, with ½-inch lead pipes, screwed to the sides, with brass ferrules. The distal ends of the lead pipes are drawn out into narrow jets. As this arrangement enables water to fall into the exhibition tanks with considerable force drawing a good amount of air bubbles along with it, it ensures efficient aeration of water as long as circulation is maintained. However, as a precautionary measure arrangements have also been made for the supply of air to each tank, from a suitable air compressor.

The overflow water from the exhibition tanks is led through 1-inch lead pipe into a cement conduit, which at its farthest end is connected with a 4-inch asbestos cement pipe, through which it flows into the filter tank. The filter bed is formed of five layers of loosely laid bricks, one layer of road metal, 1 foot thick, a layer of gravel, 1 foot thick, and a layer of sand, 2 feet thick, the sand forming the topmost layer. Through this filter, water percolates from top to bottom and flows directly into the underground reservoir, from where it is drawn again through the mixing reservoir into circulation.

One of the advantages of the filter system is that it reduces the nitrogen contamination to a great extent. The chief impurity of the aquarium water, compared with that of the open sea, lies in the excessive quantity of nitrogen present in various forms and in reduced alkalinity. The excess of nitrogen is referable to dead animals or waste food and excreta of living animals. The first two of these sources of contamination are reduced with care and cleanliness and maintenance of a flow of water sufficient to prevent excessive accumulation of sediment, and by the addition of lime and lactate at regular intervals.

Sea water in the underground reservoir is renewed once in three months or at shorter intervals as need arises. For this purpose a temporary pump is erected on the seashore, and water is conveyed to the underground reservoir through 1,800 feet of 4-inch stoneware pipe specially manufactured by the Travancore Ceramic Factory.

Brackish water necessary for esturine fishes is prepared by mixing up fresh water and sea water in the required proportion. This is stored in an underground reservoir and circulated in the same manner as sea water.

Water for the fresh-water tanks is drawn from a well and the overflow water is allowed to percolate through loose sand back into the well, so as to conserve supply even during dry months.

Laboratory

The research section is accommodated in the first floor of the building, and the general arrangement is shown in Plan 2. It consists of two large biological laboratories,

a chemical laboratory, library, common room, a photographic dark room, fisheries industrial museum and the office of the Professor. The laboratories are provided with twelve bench spaces and adequate fittings for biological work. The chemical laboratory is not fully equipped but as soon as circumstances permit arrangements will be made for providing all the apparatus and chemicals necessary for oceanographical work. The number of books in the library is at present very limited; however, the central library of the University and the museum possess a number of important biological journals which are always available for use in this laboratory.

Though the main purpose of the laboratory is the study of problems having a direct bearing on the commercial fisheries, facilities are also provided for researches of a more general or fundamental nature concerning life in the sea and inland waters. The varied shore line of Travancore, and the numerous backwaters and rivers support an extensive and varied fauna, which affords opportunities for practical study of every aspect of aquatic biology, and the constant supply of these collections makes the laboratory particularly suitable for such research. The laboratory as a whole therefore now offers facilities for all kinds of biological work, and it is hoped that these facilities will be used not only by students of the Travancore University, but also by visiting research workers from other Indian Universities.

[1] See B. K. Das, *Curr. Sci.*, 1940, **9**, 110.

CENTENARIES

Richardson, Richard (1663-1741)

RICHARD RICHARDSON, a British botanist and antiquary, was born at North Bierley 6 September 1663. He studied at Bradford School and at University College, Oxford. In 1671 he entered the Gray's Inn. Later in 1687 he went to Leyden and studied Botany under the celebrated Professor Paul Hermann. When he returned home, he practised medicine but did not take fees, as he had ample means at his command.

His main interest was in botanical travels. His garden was considered the best collection of his days. He is reported to have constructed the second hot-house in England. He also collected a valuable library of botanical and historical books.

He was elected F.R.S. in 1712. He made several contributions to the *Transactions* of the Royal Society.

Richardson is acknowledged as having enlarged the list of British plants by persistent travel and investigations throughout the British Isles. He is also said to have fixed the habitats of several specimens.

Richardson died 21 April, 1741.

Sargeant, Charles Sprague (1841–1927)

CHARLES SPRAGUE SARGEANT, an American arboriculturist, was born in Boston, Mass., 24 April, 1841. After graduating from the Harvard University in 1862 and spending some years in the army, he travelled three years in Europe. When he returned to his native land he occupied himself for a time with the development of his garden. This specialisation led to his appointment in 1872 as the Director of the Botanic Garden of his University and first as professor of horticulture and later, that is, from 1879 as professor of arboriculture in the same University.

In 1873 Sargeant was appointed director of the Arnold Arboretum, which was newly created through an agreement between the Harvard University and the testators of James Arnold, a New-Bedford merchant who had died in 1869. The University set aside 125 acres of land and received from Arnold trustees a little over 100,000 dollars the income from which was to be used for the development and maintenance of a plantation in which practically all of the trees, shrubs and herbaceous plants in the region were to be grown and labelled. Tree knowledge was also to be taught to students.

Sargeant devoted his entire energies to this work and converted the original worn-out farm partly covered with natural plantation of native trees nearly ruined by excessive pasturage into a beautiful park in which 6,500 named species of choice trees and shrubs grow as representatives of 339 genera. An incredible number of hardy plants have been introduced into American and European cultivation through the agency of this Arboretum. To-day it stands foremost in its field.

Synchronously with these foundations for dendrology a library was established which has now grown to 40,000 publications on woody plants—largely at Sargeant's own expense. Sargeant's special field of research was ligneous plant. The fourteen volumes of the *Silva of North America* (1891–1902) with illustrations of every species of tree then known north of Mexico is unequalled in its value. The *Woods of the United States* (1885) and the *Report on the forests of North America* (1884) forming volume 9 of the Tenth Census are his earlier works. Sargeant's full bibliography exceeds 200 items. His very latest publication (1927) fittingly deals with the realised idea of his life: *The greatest garden in America, the Arnold Arboretum.*

Sargeant died 22 March 1927.

S. R. RANGANATHAN.
University Library,
Madras.

POLYGALA SENEGA LINN.

POLYGALA SENEGA belongs to a widely distributed family *Polygalaceæ* which consists of 10 genera and nearly 700 species spread all over the world with the exception of New Zealand, Polynesia and Arctic Zone. Most members of this vast family are more or less toxic and expectorants, some bitter and emetic, and a few acrid and poisonous.

P. senega is a plant of the Central and North America. The dried roots (senega snakeroot) as they appear on the market are irregular, twisted and taper from a thickened tuber bearing the remains of the small stem. The root bark is yellowish in colour, with a peculiar, somewhat rancid, odour recalling that of gaultheria. Taste is acid, sweetish and somewhat acidic.

Senega root which is tonic, expectorant and emetic, normally contains 3–4·5 per cent. of a mixture of saponin, a neutral saponin senegin ($C_{32}H_{52}O_7$) and an acid saponin polygolic acid ($C_{32}H_{36}O_{10}$)[1]; a volatile oil (about 0·3 per cent.) which has been identified as methyl salicylate and valerate[2] and free salicylic acid (0·06 per cent.). The root contains about 5 per cent. of a fixed oil (Sp. gr. 0·9616 at 18° C.) consisting of olein (74 per cent.) palmitein (8 per cent.) and a little valerein.[3] Apart from the above a small quantity of a glucoside gaultherin has also been traced.

The constituents on which the pharmaceutical value of senega depends are the saponins and the glucoside gaultherin which on enzymic hydrolysis yields the methyl salicylate in the plant. These constituents are found in varying proportions in the following species.

1. *Neutral and acid saponins*:
   In the root of *Polygala amara* Linn., *P. alba* Nutt. (Bastard senega), *P. senega* Linn. (snake root) and *P. tenuifolia* Willd. (Japanese senega).
   In the root barks of *P. major* Jocq., *P. angulata* DC., *P. boykini* Nutt., *P. Caracasana* HBK, *P. diversiifolia* Linn., *P. latifolia* Torr., *P. pavciflora* Willd., *P. purpurea* Nutt., *P. sanguinea* Michx., *P. chambœbuxus* Linn., *P. monticola* H. et B., *P. virginica*, *P. paniculata* Linn. and *P. vulgaris* Linn.
2. *Methyl salicylate*:
   In the root and root bark of *P. senega* Linn., *P. senega* L. var *latifolia* Torr et Gr., *P. boykini* Nutt., *P. rarifolia* DC., *P. javana* DC., *P. variabilis* HBK, *P. baldwinii* Nutt., *P. serpyllacea* Weihe, *P. calcarea* Schultz, *P. depressa* Wend, *P. alba* Nutt., *P. oleifera* Heck, *P. violacea* St. Hil, *P. vulgaris* Linn., *P. tenuifolia* Willd. and *P. amara* Linn.

Those species which have both the saponins and the methyl salicylate, therefore, are *P. senega* Linn., *P. boykini* Nutt., *P. amara* Linn., *P. tenuifolia* Willd., and *P. vulgaris* Linn. Consequently these are the ones which are officinal in various pharamacopœias. Roots of *P. senega* Linn. is officinal in Europe, Great Britain, and United States of America, root of *P. tenuifolia* Willd. in Japan, root of *P. vulgaris* Linn. and flowering tops of *P. amara* Linn. in Portugal.

Apart from the officinal species many others are stated to be used medicinally. These are *P. calcarea* Schultz, *P. major* Jocq., and *P. serpyllacea* Weihe in Europe; *P. sanguinea* Michx and *P. alba* Nutt. in North America; *P. paniculata* Linn. in Brazil; *P. myrtifolia* Linn. and *P. tenuifolia* Willd. in South Africa and *P. Siberica* Linn. in China, Japan, Indo-China and Malaya.

The common adulterants of *P. senega* are twigs and shoots of *P. senega*, the root of *P. alba* which contains 1 per cent. senegin and some methyl salicylate,[4] *Parrax quinquefolius*, *Cyperipedium pubescens* and *Ionidium ipecacuanha*.[5] Grimme[6] has suggested that senega, the active principle of which is saponine can be replaced by radix primulæ.

In India the following polygala have been used in the indigenous system of medicine:—

P. crotalarioides Ham [*Vern* Nilkanth (Hind) a perennial herb of temperate Himalayas), *P. chinensis* Linn. [*Vern* Common Indian milk wort (Eng.), Merudu or Miragu (Hind) an annual herb found throughout India upto 5,000′], *P. telephioides* Willd. (an annual herb found in Carnatic, Nellore or Travancore) *P. glomerata* Lour. (found in Sikkim, Assam and Khasia Hills) and *P. sibirica* Linn. syn. *P. Heyneana* Wight and Arn (found in temperate and sub-tropical Himalayas, N.W.F. Province, Punjab, Khasia Hills and Western Ghats chiefly above 6,000′).

Dymock in *Pharmacogrophia Indica* remarks that *P. telephioides* Willd. and *P. chinensis* Linn. "like senega owe their medicinal properties to the presence of a substance closely related to, if not identical, with saponine". Based on these remarks Watt, in *Dictionary of Economic Products of India* states that "Indian species of polygala may prove efficient substitutes for *P. senega*, which is neither a native of this country nor cultivated here".

There is no chemical literature on any of the Indian polygala and it is, therefore, impossible to say as to which of these may be a substitute for *P. senega*. It is possible that *P. sibirica* of Indian origin may be found to contain the same active constituents as the Japanese species which in that country is used medicinally. Nothing, however, can be stated with any confidence in absence of any published work.

S. KRISHNA.

1 Kobert, *Arch. Path. Pharm.*, **23**, 233.

2 Reuter, *Arch. Pharm.*, **27**, 309.

3 Schroeder, *Arch. Phrrm.*, **243**, 628.

4 Maish, *Amer. J. Pharm.*, 1892, **177**, Rusby, *Bull. Pharm.*, 1892, 163.

5 Tunmann, *Pharm. Central.*, **49**, 61.

6 Grimme, *Munch. Med. Wochschr.*, **69**, 50.

SCIENCE NOTES AND NEWS

Chemical Constants of Lac.—The London Shellac Research Bureau has published a bulletin entitled "Chemical Constants of Lac—Some Notes on the Acid, Saponification and Hydroxyl Values of Lac", copies of which may be had from the Indian Lac Cess Committee.

The bulletin shows that the acid value of lac has been determined with three different indicators: Alkali Blue 6B as an internal indicator gives a sharp end-point, and it has been found preferable to use 0·1N alcoholic potash for titration instead of the customary 0·5N.

At least four hours' heating on a water-bath with 0·5N alcoholic potash is necessary to effect complete saponification, further complete saponification is not obtained with absolute alcoholic potash; the presence of water is necessary; and optimum results are obtained with 10 per cent. of water in the alcoholic potash.

For determination of the hydroxyl value of lac, Normann's method has been found convenient and gives reliable results, but it is necessary to allow at least four hours' refluxing with 0·5 N., 90 per cent. alcoholic potash to saponify completely the acetylated lac product.

A New Method for the Preservation of Vegetables.—In addition to the two universal methods of canning and drying vegetables, a new form of preservation has come to light. This is compressing vegetables.

It has been claimed that each pound of compressed vegetables is equal to approximately 12 lbs. of finest fresh vegetables and in this form will keep for an indefinite period under any climatic conditions.

Luminous Paints.—The possibilities of manufacturing luminous paints from Indian ores and from calcium, strontium and barium sulphides at fairly cheap prices, have been indicated by the work carried out at the Alipore Test House, Calcutta. These paints have already been tried in the air raid precaution measures in Calcutta and a demonstration of their effects has been arranged at the Government Test House, Alipore.

The importance of luminous paints was realised in the last Great War, when they were employed for illuminating aeroplane dials, gun sights for night firing, and numbers of vehicles and cycles. The present war, with the increased effectiveness of the bomber and the necessity for black-out restrictions, has given a great impetus to the study of the production of cheap luminous paints.

Paints from Indian Sources.—At least a dozen paint factories are operating in India to-day. These are producing dry colours, paste paints, mixed paints, enamels, varnishes, and oils (excluding raw linseed oil)—virtually every kind of paid manufacture from cheaper qualities to meet the demand of the Indian bazaars to the production of highly specialised qualities for use by railways, shipping, and industrial organizations of all descriptions.

They can also manufacture paints required for war purposes including anti-vesicant, camouflage, and fire-retarding paints.

In addition to paints for such diverse purposes as the protection of bridges or the decoration of India's palaces, a wide range of specialized finishes is produced for industrial purposes. These include synthetic and natural gum enamels and varnishes, vegetable oils, both heat- and chemically-treated and stabilized emulsions of various types, their application ranging from the painting of railway passenger coaches to the water-proofing of indigenous cotton canvas.

Modern research is helping Indian paint industry in many ways. In the laboratories of the Director of Scientific and Industrial Research, has been developed a technique for manufacturing varnishes and paints from the bhilawan nuts to the satisfaction of the trade. The film is more flexible and resistant to shock than that given by any other product in the market.

The Indian Institute of Science has completed research on the manufacture of pigmented lacquers in powder form and the Department of Director of Development, Cuttack, for lacquers on wood. Bleached lac, an important article in the plate varnish and nitro-cellulose lacquer industries and hard lac resin for the varnish and electrical industries have been produced at the Indian Lac Research Institute.

As a result of researches carried out at London and Namkum, several processes of making varnishes from shellac and drying oils have been discovered.

The College of Science in Nagpur, is making attempts to manufacture white lead paint, as well as metal and wood polishes.

The indigenous product has many advantages over the imported articles, for Indian paints, enamels and varnishes are manufactured under the actual conditions in which they are ultimately intended to be used. The factories are now practically all equipped with chemical testing laboratories and control testing rooms, where highly skilled chemists and other workers give specialised attention to each product and the particular problems arising in its general use.

In addition to meeting the growing demand for paint and paint products in this country, Indian supplies have been regularly exported to Burma and Ceylon. With the outbreak of the war, however, additional demands are being made upon the Indian industry and in recent months exports have been made to the Near and Far East, to Persia, Mesopotamia, Africa, Siam, Singapore and the East Indies.

Agricultural Research on Jute.—An important step in the development of agricultural

research on jute in this country has been taken by the establishment of three Agricultural Research Sub-stations by the Indian Central Jute Committee at Kishoreganj (Mymensingh), Konda (Brahmanbaria) and Narayanganj. These centres are situated in some typical and representative jute-growing areas, and according to a press note recently issued by the Indian Central Jute Committee, have started to function from the beginning of this month.

Agricultural Research workers now fully realize that plant-breeding work to be fruitful must be carried on under representative conditions; it is the object of the Central Jute Committee's Research Sub-stations to provide such conditions. They will be run by trained field staff under the control and supervision of the Committee's Director of Jute Research Laboratories at Dacca. The Government of Bengal through the Department of Agriculture are co-operating with the Central Jute Committee in this work, and have already agreed to contribute half the non-recurring and recurring cost of this scheme.

Par-boiled Rice for Troops.—As par-boiled rice is richer in proteins and minerals, it has been decided to make a trial issue to troops to test its palatability, etc. This rice has better keeping qualities and is more economical than the raw milled rice. It is understood that 57 per cent. of the total quantity of rice grown in India is par-boiled before being placed on the market.

Flax Substitute.—A flax substitute "celin" which has selected jute as a base, has been manufactured in Northern Ireland, according to the March issue of the Indian Central Jute Committee's *Bulletin*.

It is claimed that the new fibre can be spun, woven and finished on orthodox flax machinery and is cheaper than flax. Conversion of jute into "celin" is performed by chemical means in a series of tank treatments which take only a few days. Subsequently, it is rolled to the required degree of softness, dried and ready for delivery to the flax spinning mills.

"Celin" has been successfully used as weft in the production of practically all classes of domestic goods and pure "celin" warp and weft have been used in the production of canvas, which is claimed to be better than the cotton-jute union fabric evolved in India.

Another possible new use for jute is in the production of felt. It has been found that thermoplastic fibres such as vinyon can be utilised to produce felts from mixture with other fibres such as glass, asbestos, wool, hair, jute, cotton and rayon, of which jute is the cheapest. By varying the proportions a range of products from soft wadding-like insulating materials to hard flexible tilling can be produced.

Indian Food Fishes.—With the aim of dividing the chief varieties of Indian "food" fish into well-defined groups, the Agricultural Marketing Adviser has compiled and published a "Preliminary Guide to Indian Fish, Fisheries, Methods of Fishing and Curing". The guide is primarily intended for lay-men and instead of minute scientific descriptions provides a catalogue of important characteristics, distinctive markings, peculiarities of shape and other data to enable the lay man to recognise the fish. There is a diagram on art paper of each of the varieties described.

The principal Indian fisheries and the gear used are described at length and illustrated with a number of plates. Many of the implements in use have not changed for nearly a century. In the back-waters of Malabar and South Canara, for instance, the fishermen still use the cross-bow and blow-gun, the fish-spear is used on the Ganges and other rivers to catch cat-fish, while sharks, rays and dolphins are caught off the west coast with harpoons thrown from canoes.

College of Pharmacy.—According to an Associated Press message dated March 19, 1941, the College of Pharmacy Committee appointed by the Government of Bengal with Sir R. N. Chopra as Chairman, has recommended the establishment of a College of Pharmacy in Calcutta.

It is recalled that Dr. D. E. Anklesaria of Ahmedabad agreed to donate a sum of Rs. 2,00,000 to the Government of Bengal for the establishment of such a college.

The Indian School of Mines, Dhanbad.—Of the 21 students who qualified at the Indian School of Mines, Dhanbad, 18 have been placed in employment or are undergoing apprenticeships and one has gone abroad for specialised studies, according to the Annual Report of the School for the year 1939–40, just received.

Recent employment enquiries show that there is increasing demand for specialists, especially in fuel technology and metallurgy. Of the students in employment, two have been sent by their employers to attend advanced courses elsewhere in metallurgy.

The annual Mining Survey Camp was held in November, 1939, at Sijua Colliery, 69 students being under canvas. The Geological Survey Camp was held at Gondhudih Colliery.

The senior geological students went on two educational tours, one in the Hazaribagh, Ranchi and Singhbhum districts and the other in the Northern India Salt Range.

The total number of mining students annually visiting the mining districts, during long vacations, for practical experience, is constantly on the increase. Formerly it used to be between 30 to 40, whereas now the number from the Indian School of Mines alone is over 75 and is increasing. Most of the mining concerns have given and continue to give valuable support in this connection.

Owing to shortage of funds and war-time restrictions, the research activities have been curtailed. The work on washability of coals and the crystallographic investigation of vitrains of Indian coals were, however, continued.

Botanical Society of Bengal.—The Fifth Annual General Meeting of the Society was held on the 22nd February 1941, at the Botanical Laboratory, University College of Science, 35, Ballygunge Circular Road, Calcutta. Prof. S. P. Agharkar, President of the Society took the chair.

The Hony. Secretary (Mr. S. N. Banerji) presented the Annual Report.

The following were duly elected Office-bearers and Members of the Council for the year 1941–42:

President: Prof. S. P. Agharkar; *Vice-Presidents*: Prof. S. C. Mahalanobis, Prof. G. P. Majumdar, Mr. S. N. Bal, Dr. K. P. Biswas; *Hony. Treasurer*: Mr. I. Banerji; *Members*: Dr. S. R. Bose, Dr. J. C. Sen Gupta, Prof. J. C. Pal, Prof. M. B. Dutta, Prof. M. L. Chakravarty, Dr. N. K. Chatterjee, Mr. E. A. R. Banerji, Mr. R. M. Datta, Dr. J. Chaudhuri; *Hony. Secretaries*: Dr. S. M. Sircar, Dr. B. C. Kundu; *Hony. Auditors*: Mr. J. C. Banerji, Dr. J. B. Mukherji.

An exhibition and a conversazione were organised on the occasion. The list of exhibits included fossil plants, economic and horticultural plants, different strains of rice and sorghum and their hybrids, mulberry with reference to silk-worm rearing, Marine Algæ, Mycology and Plant Pathology, Pteridophytes, Gymnosperms, Cytology. Several experiments showing life processes in plants, different kinds of vegetable fibres, medicinal plants and drugs, Himalayan plants, Alpine flora, Khasi Hill flora, Mangrove vegetation, Parasitic seed plants, Insectivorous plants and Bengal timbers.

A whole day excursion was organised to Sundribans Forest *via* Gosaba, on the 23rd inst. where a rich collection of the mangrove vegetation was made.

The National Academy of Sciences, India.—At the meeting of the Council held on Friday, 21st March 1941, the following resolution was passed: "This meeting places on record its deep sense of sorrow and grief on the sudden and untimely death of the Hon'ble Sir Shah Muhammad Sulaiman, Judge of the Federal Court of India, Ex-President and Senior Vice-President of the Academy, who was such a distinguished and esteemed member of our Academy, and conveys its heartfelt condolence to Lady Sulaiman and her children."

Biological Abstracts.—During 1940, 605 contributions to the increasingly popular field of bioclimatology were summarized in *Biological Abstracts*. The *Bioclimatology-Biometeorology* section proper reported 234 contributions that had appeared in 127 current periodicals and reviewed 31 books. References to climate and weather effects on human physiology, animal and plant behaviour were reported in 340 abstracts in other sections of *Biological Abstracts*, and their subject-matter was outlined, month by month, at the beginning of the *Bioclimatology-Biometeorology* section.

These are the results of the first complete year of reporting research in this field.

Bombay University.—Mr. R. P. Masani has been reappointed Vice-Chancellor of the Bombay University with effect from April 1, 1941.

Aligarh University.—Sir Ziauddin Ahmad was elected Vice-Chancellor of the University at the meeting of the Court held on 20th April.

Madras University.—Mr. P. S. Srinivasan has been admitted to the degree of Doctor of Science, in consideration of his thesis entitled *"The Elastic Properties of Molluscan Shells and the Elastic and Thermal Properties of Timber"*.

University of Calcutta.—Mr. S. Raghavender Rao has been admitted to the Degree of Doctor of Science in consideration of his thesis entitled *"Studies on the Epidemiology of Plague"*.

MAGNETIC NOTES

The month of March 1941 was more active than the preceding month. There were 6 *quiet* days, 18 days of *slight* disturbance, 6 of *moderate* disturbance and one of *very great* disturbance as against 9 quiet days, 12 of slight disturbance, 6 of moderate disturbance, 2 of Great disturbance and 2 of very great disturbance during March of last year. The day of largest disturbance during March 1941 was the 1st and that of least disturbance the 26th. The characters for individual days are given in table below:

Quiet days	Disturbed days		
	Slight	Moderate	Very great
10, 16, 17, 24–26	3–9, 11–13, 15, 18, 20–23, 27, 29.	2, 14, 19, 28, 30, 31.	1

Three magnetic storms, 2 moderate and one of very great intensity were recorded during the month of March this year as against 3 storms (2 of great intensity and one of very great intensity) during March 1940. The mean character figure for the month of March 1941 is 1·03 as against the same figure for March of last year.

M. R. Rangaswami.

SEISMOLOGICAL NOTES

March 1941.—During the month of March 1941, one moderate and five slight earthquake shocks were recorded by the Colaba seismographs as against two moderate and four slight ones recorded during the same month in 1940. Details for March 1941 are given in the following table:

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of Focus	Remarks
		H.	M.	(Miles)		(Miles)	
March 1941							
12	Slight	03	19	1310			
12	Slight	19	47	4390			
13	Slight	03	07	4420			
16	Moderate	13	12	5270			
17	Slight	02	25	810	Epicentre in the neighbourhood of the Maldive Islands in the Indian Ocean		
29	Slight	02	43	1470			

ASTRONOMICAL NOTES

Planets during May 1941.—Mercury will be in conjunction with the Sun on May 6 and will afterwards pass into the evening sky; it reaches greatest elongation from the Sun on June 4. Venus is an evening star and will be visible low down in the western sky soon after sunset; it is gradually separating from the Sun and at the end of the month, its altitude at sunset will be about 11°. Mars is nearly on the meridian at sunrise and continues to increase in brightness, its stellar magnitude on May 31 being 0·1.

The three major planets, Jupiter, Saturn, and Uranus are all too close to the Sun and not favourably situated for observation. Saturn will be in conjunction with the Sun on May 9, Jupiter on May 19, and Uranus on May 17. Neptune will be on the meridian at about 8 p.m. and continues to move in a retrograde direction in the vicinity of the star β Virginis (magnitude 3·8).

The meteoric showers known as η Aquarids may be seen in the early morning hours before sunrise between May 2 and 6. They are supposed to be associated with Halley's Comet and the position of the radiant point is given by R.A. 22^h 32^m and Declination 2° South.

T. P. B.

ANNOUNCEMENTS

Kalyankumar Mukherjee Scholarship for 1941.—Applications are invited from graduates of the Calcutta University for the award of the Scholarship for the year 1941. The following subjects have been selected for investigation by the candidates.

(1) Tuberculosis as a community disease.
(2) Nutritional disease in children up to the age of two.

The successful candidate will receive a non-recurring research grant of about Rs. 750. Applications should reach the Registrar of the Calcutta University *before 30th June* 1941.

Essential Oil Industry.—On the recommendation of the Board of Scientific and Industrial Research, the Government of India have set up an exploratory committee for surveying the present position of the essential oil industry in this country. The Committee will consist of Mr. P. A. Narielwala, General Manager, Tata Oil Mills Company Limited, Bombay, (convener), and Mr. J. N. Rakshit, Chemical Examiner to the Government of India (retired).

Enquiries and suggestions made to the Director, Scientific and Industrial Research, concerning the industry and trade as well as the supply of aromatic trees, plants and grasses, will be considered by the Board and the Committee.

Testing of Materials.—With a view to afford some measure of relief in the matter of fees to nascent and undeveloped Indian industries the Government of India have decided, as an experimental measure for one year, to reduce the testing fees to a certain definite extent in cases where Government are satisfied as to the need for concession. To take advantage of this concession firms and individuals will have to apply to the Superintendent, Government Test House, preferably through the Directors of Industries of the respective provinces, substantiating their claims to such concession.

A wide variety of materials, including textile goods, electrical equipment and stores, building and general engineering materials, vacuum brake fittings, metals and alloys, minerals and ores and miscellaneous stores, such as oils, lubricants, paints, varnishes, chemicals, fuels, etc., etc., are tested in the Government Test House, to determine their qualities. The Government of India issue two "Schedules of charges" for tests and analyses—one for Government Departments and the other for private firms and individuals.

Test certificates, bearing the Government seal, which can be used by the firms and individuals for commercial purposes, are issued to all samples tested.

* * *

We acknowledge with thanks the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4577–78.

"Journal of Agricultural Research," Vol. 61, Nos. 4–8.

"Agricultural Gazette of New South Wales," Vol. 52, Pt. 2.

"Indian Journal of Agricultural Science," Vol. 9, Pt. 1.

"Biological Reviews," Vol. 16, No. 1.

"Journal of the Indian Botanical Society," Vol. 20, No. 3.

"Journal of Chemical Physics," Vol. 9, No. 2.

"Journal of the Indian Chemical Society," Vol. 17, Nos. 11–12.

"Chemical Products," Vol. 4, Nos. 1–2.

"Indian Central Jute Committee" (Bulletin), Vol. 3, No. 12.

"Bulletin of the American Meteorological Society," Vol. 21, No. 10.

"Indian Medical Gazette," Vol. 76, No. 3.

"Journal of Nutrition," Vol. 21, No. 2.

"Nature," Vol. 146, Nos. 3713–14 and Vol. 147, No. 3715.

"Indian Journal of Physics," Vol. 14, Pt. 5.

"Canadian Journal of Research," Vol. 18, No. 11 (A.B.C.D.).

"Sky," Vol. 5, No. 5.

"Science and Culture," Vol. 6, No. 10.

"Indian Trade Journal," Vol. 140, Nos. 1812–15.

BOOKS

Temperature, its measurements and control in science and industry. By The American Institute of Physics. (Reinhold Publishing Corporation, New York), 1941. Pp. xiv + 1362. Price $11·00.

Temperature measurement. By Robert L. Weber. (Edwards Brothers Inc., Michigan), 1941. Pp. x + 171.

Practical Histology and Embryology. By Nellie B. Eales. (Macmillan Co., London), 1940. Pp. vi + 111. Price 3*sh.* 6*d.*

The Indian Sugar Industry (1940 Annual). (Messrs. Gandhi & Co., Calcutta), 1941. Pp. 350. Price Rs. 4–8–0 or 12*sh.*

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

March 1941. SECTION A.—I. D. SETH: *Reflection and refraction of attenuated waves in semi-infinite elastic solid media.* T. M. K. NEDUNGADI: *Effect of crystal orientation on the Raman effect in naphthalene and benzophenone.* From the observed changes in intensities and the known molecular orientations in the crystal, it is deduced that the incident light vector vibrating in the plane of the aromatic ring excites some oscillations of the molecules much more strongly than the light vector perpendicular to the plane. R. D. DESAI AND W. S. WARAVDEKAR: *Heterocyclic compounds. Part XII. Chromones from resacyl and gallacylphenones containing long-chain acyl groups, and some chemical properties of these hydroxy-ketones.* S. ASHRAF ALI, R. D. DESAI AND H. P. SHROFF: *Heterocyclic compounds. Part XIII. Abnormal alkaline hydrolysis of some 4-isopropyl-1:2-α-naphthapyrones.* T. A. S. BALAKRISHNAN: *An elementary theory of the coronas of water droplets.* The water droplets are treated instead of as opaque discs as perfectly transparent spheres in passing through which the wave fronts undergo a phase retardation. K. NEELAKANTAM AND L. RAMACHANDRA ROW: *The lanthanum nitrate test for acetate in inorganic qualitative analysis.* The above test for acetate ion has been examined for use in the routine analysis for mixtures of inorganic substances including the acetate, oxalate, and tartrate radicles. V. SUBBA RAO AND T. R. SESHADRI: *Chemical investigation of Indian lichens. Part III. The isolation of montagnetol, a new phenolic compound from* Roccella montagnei. MOHAMMAD SHABBAR: *On the existence of a metric for path spaces admitting the lorentz group.* S. V. ANANTHAKRISHNAN AND V. PASUPATI: *Substitution in polycyclic systems. Part II. The nitro-derivatives of fluoryl 9-trimethylammonium compounds.* P. BHASKARA RAMA MURTI AND T. R. SESHADRI: *A study of the chemical components of the roots of* Decalepis Hamiltonii *(Makali Veru). Part I. Chemical composition of the roots.* K. V. BOKIL AND K. S. NARGUND: *Synthesis in the chaulmoogric acid series. Part III. Synthesis of* dl-*hydnocarpic acid.* Synthesis of *dl*-hydnocarpic acid has been effected for the first time and described. V. V. NARLIKAR: *A classical limit of heavy homogeneous spherical masses.* TRIPURA CHARAN SARKAR: *The lead ratio of a crystal of monazite from the Gaya District, Bihar.* The pegmatites of Gaya may be considered as the last phase of igneous activity in post-Dharwar and pre-Cuddapah times.

SECTION B.—P. N. GANAPATI: *On a new myxosporidian* Henneguya otolithi *N. Sp. A tissue parasite from the bulbus arteriosus of two species of fish of the genus* Otolithus. L. S. S. KUMAR AND S. SOLOMON: *A list of hosts of some phanerogamic root-parasites attacking economic crops in India.* G. N. RANGASWAMY AYYANGAR AND B. W. X. PONNAIYA: *Studies in* Sorghum halepense *(Linn.) Pers—the Johnson grass.* M. A. BASIR: *Two new nematodes from an aquatic beetle.* L. S. S. KUMAR AND G. B. DEODIKAR: Commelina alisagarensis *Kumar and Deodikar: a new species from Hyderabad, Deccan, India.* SYED MUZAMMIL ALI: *Studies on the comparative anatomy of the tail in sauria and rhynchocephalia. I.* Sphenodon punctatus *Gray.* K. H. ALIKUNHI: *On a new species of* praegeria *occurring in the sandy beach, Madras.*

Indian Chemical Society: (*Journal*)

November 1940.—PHANINDRA CHANDRA DUTTA: *Studies in the Sesquiterpene Series. Part I. Synthesis of the Triethyl Esters of $C_9H_{15}(CO_2H)_3$, obtained from Selinenes.* G. S. KASBEKAR: *Vapour Pressures of Aqueous Solutions.* SANTI RANJAN PALIT: *Physical Chemistry of Resin Solutions. Part III. Viscosity of Shellac Solutions in Mixed Solvent.* N. R. DHAR, A. K. BHATTACHARYA AND S. P. AGARWAL: *Chemical Reactivity and Light Absorption. Part IV.* PRIYADARANJAN RAY: *Estimation of Zinc in Snake Venoms by Micro-quinaldinate Method.* KESHO DASS JAIN AND J. B. JHA: *Adsorption of Mono- and Polybasic Acids by Sugar Charcoal.*

Indian Botanical Society: (*Journal*)

February 1941.—B. SAHNI: *Palæobotany in India. II. Progress Report for 1940.* T. EKAMBARAM AND MISS V. K. KAMALAM: *Studies in absorption and transpiration. III. Effects of hypertonic solutions on leaf turgidity.* MISS V. K. KAMALAM: *Studies in absorption and transpiration. Part IV. The effect of oxygen concentrations on absorption of water and transpiration.* A. C. JOSHI AND J. V. PANTULU: *A morphological and cytological study of* Polianthes tuberosa *Linn.* M. O. P. IYENGAR AND MISS B. VIMALA BAI: *Desmids from Kodaikanal, South India.* M. O. P. IYENGAR AND S. KANTHAMMA: *A note on* heterothrichopsis viridis *gen. et sp. nov.*

March 1941.—M. J. THIRUMALACHAR: *Tuberculina on* Uromyces Hobsoni *Vize.* N. KRISHNASWAMI AND G. N. RANGASWAMI AYYANGAR: *Chromosomal alterations induced by X-rays in Bajri* (Pennisetum typhoides *Stapf & Hubbard*). GIRIJA P. MAJUMDAR: *Anomalous structure of the stem of* Nyctanthes arbortristis *L.* K. RANGASAMI: *A morphological study of the flower of* Blyxa echinosperma *Hook. F.* SULTAN AHMAD: *Higher fungi of the Panjab plains. III. The gasteromycetes.* M. O. P. IYENGAR AND K. R. RAMANATHAN: *On the life-history and cytology of* Microdictyon tenuius (*Ag.*) *Decsne.*

Imperial Institute of Sugar Technology, Cawnpore: (*Scientific Reports*)

The recent publication (I.C.A.R. 24.38/350) by the Imperial Council of Agricultural Research, of the Scientific Reports of the Imperial Institute of Sugar Technology, India, Cawnpore, covers the period, 1st October 1936 to 31st March 1939. This consists of two parts, being the reports of the Director of the Institute and of the different sectional heads. This is the first report of the Institute after its establishment in October 1936 and covers the varied activities of the Institute in carrying out research work on problems of imminent interest to the Indian Sugar Industry and in rendering technical help to several factories when called for. The reports are of great interest to sugar technologists and industrialists.

Royal Asiatic Society of Bengal

April 7, 1941.—CHRISTOPH VON FURER-HAIMENDORF: *Seasonal Nomadism and Economics of the Chenchus of Hyderabad.* W. J. CULSHAW: *Some beliefs and customs relating to birth among the Santals.* S. L. HORA AND J. C. GUPTA: *Fish from Kalimpong Duars and Silguri Terai, North Bengal.* Notes on the physical conditions of the parts of the Kalimpong Duars and of the Siliguri Terai in which collections were made are given. "A list of 58 species is given and additions and alterations made in a list of 131 species of fish of Northern Bengal published by Messrs. Shaw and Shebbeare in 1938 are explained. Taxonomic notes were given on *Lepidocephalus guntea* (Hamilton), *Semiplotus semiplotus* (McClelland) and *Barbus* (*Puntius*) *titius* Hamilton."

Meteorological Office Colloquium, Poona:

February 18, 1941.—DR. R. ANANTHAKRISHNAN: *Recent work on the reflection of radio waves from temperature discontinuities in the troposphere.*

February 25, 1941.—DR. L. A. RAMADAS: *Studies on the movements of free particles and light objects when placed in a thermal gradient.*

Erratum

Vol. 10, *No.* 3, *March* 1941: P. 173, Note on "Chromatin Bridges in the Root Tip of Groundnut", *insert* the following under Fig. 1: "The fragment found along with the chromatin bridge".

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